UNIVERSITY OF TAMPERE
School of Management

HORIZONTAL DISRUPTION FORCES IN THE VERTICALLY INTEGRATED ELECTRIC POWER INDUSTRY

Business Management

Master's Thesis

May 2017

Supervisor: Kari Lohivesi

Tommi Linnankoski

ABSTRACT

Author: LINNANKOSKI, TOMMI
Title: Horizontal Disruption Forces in the Vertically Integrated Electric Power Industry
Master's Thesis: 88 pages, 3 appendices
Date: May 2017
Keywords: co-creation, ecosystem, electric power industry, horizontal force, platform, technology, vertical integration

Vertically integrated and constructed industries have dominated businesses for the past century. In particular, these have been established in the utility industries: the telecommunications industry, the water industry and the electric power industry. The dominant model of these vertical industries saw the integration of separate value chain parts to drive economies of scale profit formation further. Advances in technology have now put these dominant vertical structures under pressure. These forces open industries for new kinds of business models and new forms of market creation.

This study focuses on the currently on-going technological transformation of the electric power industry by examining key effects of these technological drivers of change. The research objective of this study is to describe and analyse the key emerging forces of technology-driven horizontal pressures on the dominant vertical electric power industry. The electric power industry has traditionally operated under a vertical structure and has remained virtually unchanged until recently. This has been the case especially in developed markets including Europe and North America.

This study was conducted as a qualitative case research. A theoretical framework was built to examine the empirical section of this research report. The framework first presents the theory of value development and co-creation. These fields of literature are then tied into theories of platforms and ecosystems. The empirical part of this study presents the dominant vertical structure of the electric power industry. Horizontal forces of disruption that are affecting this dominant structure are then presented.

This research finds that horizontal forces are challenging the dominant vertical structure of the electric power industry. These forces include new technologies, platform development and co-creation. Horizontal forces are changing the dominant pipeline of the industry towards a focus on individual platforms. This is resulting in a development of a broad horizontal electric power ecosystem. This research raises the question of 'industry' as the traditional unit of analysis and how the platform model challenges this view.

TABLE OF CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1. Background for the Research

Vertically integrated and constructed industries have dominated businesses for the past century. In particular, these have been established in the utility industries: the telecommunications industry, the water industry and the electric power industry. Growth of these industries has been fuelled by large capital investments and the logic of capital investment. Ownership of these means of production has been the key force keeping barriers to entry high and in pushing for economies of scale (cf. Johnson, Scholes & Whittington, 2008.) This helped businesses drive out competitors by establishing monopoly-like power.

The dominant model of these vertical industries saw the integration of separate value chain parts to drive economies of scale profit formation. Value was added along individual value chain parts and delivered to the end customer to be consumed. Customers were viewed as passive participants and they could not affect the value creation process (cf. Valocchi, Juliano & Schurr, 2010.) Advances in technology have now put these dominant vertical structures under pressure. These forces open industries for new kinds of business models and new forms of market creation.

The electric power industry has traditionally operated under a vertical structure. Unlike the telecommunications industry, the electric power industry has been slow to evolve. This has been caused by a variety of reasons: strong economies of scale, legislations, and high barriers to entry (Bruno, 2011; Gottfredson, Norton, Critchlow & Sinha, 2013.) During the past two decades the telecommunications industry has merged with the information technology (IT) industry (cf. Shaughnessy, 2015), whereas the electric power industry has remained virtually unchanged until recently. This has been the case especially in developed markets including Europe and North America.

Previously telecommunications has been a highly consolidated industry with few network carriers, network infrastructure suppliers, and device manufacturers. Relationships between these companies reminded that of a cartel. Small companies had a hard time doing business or entering the market (Shaughnessy, 2015.) Other heavy and capital-intensive industries (e.g.

gas, water and transportation utilities) have taken a similar structure. This structure has been used to drive down costs to keep out competitors. Examining the fast development of telecommunications technologies we can see the possibility that similar changes might also apply to the electric power industry. The analogy can be found between products like smart phones or networks and smart grid era appliances like energy storage (Shandurkova, Bremdal, Bacher, Ottesen & Nilsen, 2012; Aho, 2016.) These new technologies may have broad effects on the electric power industry.

The telecommunications network was developed with similar technology conditions and at the same time as the electricity grid. Telecommunications development was not affected by the presence of a monopoly in the same way as the power grid. The telecommunications network was not immune to change. This change was driven by wireless services and the emergence of the Internet (Carvallo & Cooper, 2011.)

The telecommunications network horizontal restructuring can be broken up into three major milestones: first, a decision to break the dominant monopoly to engender competition; second, the birth of cellular wireless; and third, the emergence of the Internet (Carvallo & Cooper, 2011.) This change has driven value creation to adjacent levels in applications and services.

This research report focuses on the forthcoming structural disruption in the electric power industry. This report examines drivers that may impact the electric power industry reminiscent of the change that has already occurred in other utility businesses – in particular the telecommunications industry.

Structural disruption of an industry usually begins with the prior consolidation of market structure into an oligopoly with satisfactory margins. Excluded actors, increasingly drawing on open-source technologies as well as work principles that open access to a certain industry, drive early horizontal pressure. In the next phase a new content layer or growth of awareness begins to take shape as consumers experience alternatives to oligopoly offers, often as participants or co-creators (Shaughnessy, 2015.) These changes begin to open up space in vertical sectors and push for horizontal development.

Shaughnessy (2015) argues that all businesses are now horizontal. There are no categories or market barriers other than those that are imagined by us. This is a result of business becoming global, transactions becoming Internet -defined and most advantage coming from how individuals feel about the economic relationships they enter. This is creating new ways of conducting business based on platforms. These platforms are becoming the twenty-first century utilities. This creates monopoly power simultaneously enabling business revolution and business opportunity (Shaughnessy, 2015.)

Technology development provides significant potential for transforming and disrupting the electric power industry. There is previous research on the impacts of individual technologies like renewable energy resources (Richter, 2013) and smart grids (Erlinghagen & Markard, 2012). However, there is a lack of studies that address this shift beyond energy production and distribution (Bergman, Dukeov, Ahola & Ahonen, 2016). Focusing on the whole industry allows the examination of broader technological forces impacting the industry.

This study focuses on the electricity power industry during a time when there is an on-going discourse related to the transformation of the sector. Carvallo & Cooper (2011) state that the electric grid needs more than to be redesigned completely – it needs to be disrupted (Kananen, 2017). Today's grid was designed to meet the needs of the previous century with its technologies. The grid is challenged by the need for quality power at reduced costs and the need to accommodate new technologies that mostly reduce revenues, and reduce the reliance on fossil fuels (Carvallo & Cooper, 2011.) These changes can be profound and have a broad impact on the dominant vertical industry structure.

1.2 Research Objective and Research Questions

This study focuses on the currently on-going technological transformation of the electric power industry by examining key effects of these technological drivers of change. **The research objective of this study is to describe and analyse the key emerging forces of technology-driven horizontal pressures on the dominant vertical electric power industry.**

In order to meet this research objective, this study needs to:

1) Describe the dominant vertical structure of the electric power industry

2) Describe the key emergent forces of technology-driven horizontal pressures

3) Analyse these horizontal forces of disruption in the electric power industry

1.3 Key Terms

Disruption and Disruptive Technology = Most markets evolve based on sustaining technologies. Occasionally, disruptive technologies emerge. These are technologies that result in worse product performance – at least on the near term. In the near future these disruptive technologies can be performance competitive in the same market and start to take over (Christensen, 1997.)

Electric Power Industry = an energy-consuming sector that consists of electricity only and combined heat and power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public (Energy Information Administration, 2017).

Energy = is the power from a source that can do work. In this study energy is used synonymously with the term electricity. This is due to multiple resource materials making use of both terms synonymously. Energy can be viewed as a hypernym for electricity.

Horizontal forces = forces that create horizontal pressure in an industry. These can include new technologies, co-creation and platform development among other horizontal forces.

Horizontal pressure = pulls down vertical industries and their re-establishment as broad-based horizontal ecosystems. In the industrial era the economy fell into vertical industry. The convergence of telecoms and IT is changing this and reordering the economy around new capabilities (cf. Shaughnessy, 2015)

Industry and Sector = is a group of companies that offer a product or a group of products that are close substitutes for one another. This includes the set of all sellers of a service or product (Law, 2016a.) These can include the electric power industry or the telecommunications industry. The term sector is used in this study as a synonym for industry as the electric power industry is often referred to as the electric power sector in literature.

Vertical Integration and Vertical Structure = moving a company's value system backwards or forwards (Johnson et al., 2008). This study refers to a vertical structure where vertical integration is used to a wide extent and value is delivered in a one-way transaction.

1.4 Outline of the Report

This research report consists of six main Chapters. This first Chapter was the introduction, in which the topic of the report, the research objectives, and the key terms were outlined.

The second Chapter presents the theoretical framework through which the empirical findings are looked at. The theoretical framework first presents the theory of value development and co-creation. These fields of literature are then tied into the theories of platforms and ecosystems.

The third Chapter presents the methodology of the research. This Chapter describes the chosen research methods in addition to the description of research process and empirical data gathering.

The fourth Chapter and fifth Chapter examine the empirical findings. The fourth Chapter presents the dominant vertical electric power industry. The fifth Chapter presents the key emergent forces of technology-driven horizontal pressures.

The sixth Chapter presents the findings of the research. This Chapter reflects upon the theoretical framework presented in Chapter 2 from the perspective of Chapters 4 and 5. The sixth Chapter also presents a discussion section and examines the study's contribution to managers and academia. The Chapter ends with future research questions that rose during the research process.

2 ECOSYSTEM AND PLATFORM DEVELOPMENT

2.1 Value Development

2.1.1 Vertical and Horizontal Growth

Vertical and horizontal integration are central strategies for structuring organisations. Integration refers to the combination of two or more organisations under the same control for mutual benefit. This is achieved through capturing a larger market share, reducing costs by saving overheads, reducing competition, cooperating on research and development, pooling resources and enhancing competitive advantage (Law, 2016b.)

Vertical integration occurs when companies push for backward or forward integration. Backward integration refers to the development of activities that are concerned with the inputs of the organisation's current business. Forward integration refers to the development of activities that are concerned with the company's outputs. Vertical integration thus moves the company's value system backwards or forwards (Johnson et al., 2008.)

Expanding in the value network of a company can mean the move towards complementary or adjacent activities. This is referred to as horizontal (lateral) integration by moving a company's activities into those that are complementary to present activities. Horizontal diversification occurs when a firm expands outside its current industry (Johnson et al., 2008; De Wit & Meyer, 2004.)

In horizontal (lateral) integration organisations produce similar products or services or carry through the same stage in the value chain. Therefore, they are competitors. In a monopoly situation horizontal integration is complete, whereas in an oligopoly there is significant horizontal integration. In vertical integration organisations obtain control of their suppliers (backward integration) or the concerns that buy the organisation's products or services (forward integration) (Law, 2016b.) Figure 1 outlines vertical and horizontal corporate growth directions.

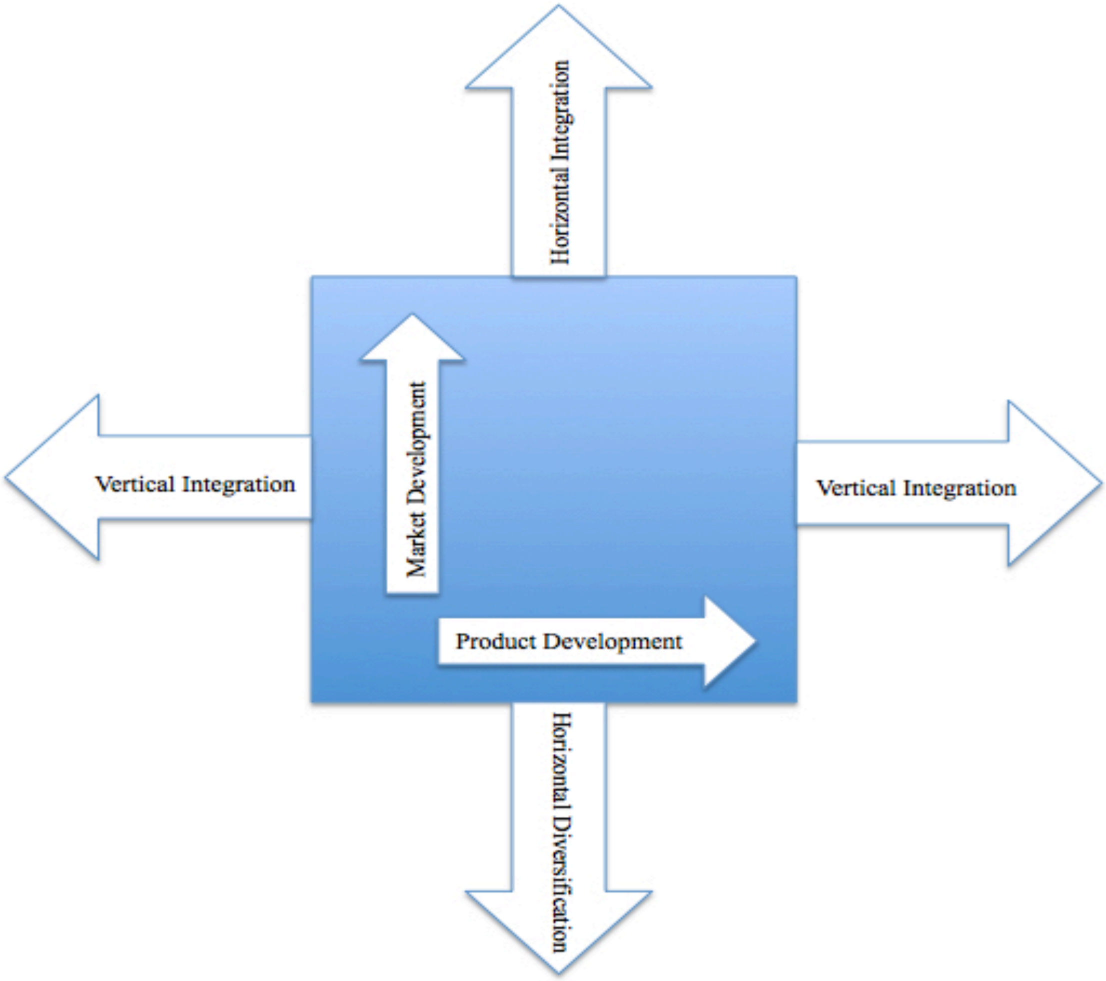


Figure 1 – Corporate Growth Directions (Adapted from De Wit & Meyer, 2004)

Diversification drives growth beyond current products and markets, but still remains under the value network or capabilities of the organisation. Vertical integration and horizontal integration fall under this category. It should be noted that value links and capabilities are distinct. A link in the value network does not imply the existence of capabilities. Unrelated diversification instead is the diversification of services and products outside the value network or current capabilities. This can also be referred to as a conglomerate strategy. This takes place between firms in different value chains (Johnson et al., 2008; Law, 2016b.)

2.1.2 Beyond Value Chains

Value chains have been used for decades to analyse and understand industries (cf. Porter, 1980, 1985). They have been very useful tools in showcasing the chained linkage of activities that exist in the physical world in traditional industries. They have also framed our thinking about value creation and value itself. As products and services become evermore dematerialized, the value chain no longer serves as a suitable tool to uncover sources of value and analyse many industries today (Peppard & Ryland, 2006.)

Normann and Ramírez (1993) state the strategy is the art of creating value. However, in a constantly changing competitive environment the logic of value creation is also changing. This is making strategic thinking evermore important and difficult. Traditional thinking about value is based on models and assumptions of an industrial economy. In this view, every organisation occupies a position on a value chain. Suppliers provide inputs upstream. Companies then add value to these and pass them downstream to the next actor in the chain. The value chain concept not only implies that value creation is sequential, but also that value is added. The next actor is a customer, whether the final consumer or another business. Global competition, new technologies and changing markets are opening up new ways of creating value (Normann & Ramírez, 1993; Ramírez, 1999.)

The realities of the "network economy" require rethinking the traditional ways of analysing competitive environments. Pepper and Ryland (2006) present the value network concept to answer to this need. Old linear models do not address the nature of competitors, complementors, alliances and other members inside business networks. By adopting a network approach, organisations can focus on the value-creating system itself instead of focusing on the industry or company. Value creation has to be looked at from the view of how organisations create value within the context of the network, instead of perceiving the organisation as an isolated unit (Pepper & Ryland, 2006.)

The dynamic nature of the networked economy is one of its most important aspects. An action by a participant in the network can have an effect on other network members. Action by a network participant may also require further action by other network members to be effective. This can have wide implications. A firm is part of a network that creates its own change. Therefore, when analysing a network all aspects of the network must be included. Networks evolve over time instead of remaining stable. This evolution can be the result events, including new technologies, regulatory events or competitor strategies. In the value network concept, value is co-created by the players in the network (Pepper & Ryland, 2006.)

Normann and Ramírez (1993) state that the key strategic task for companies is the reconfiguration of roles and relationships among the constellation of actors, thus mobilizing the creation of value by new players and in new forms. Successful firms perceive strategy as a systemic social innovation – continuous design and redesign of complex business systems. Building better fit between relationships and knowledge is the secret of value creation (Normann & Ramírez, 1993.)

2.2 Co-creation

2.2.1 Prosumption

Co-creation and co-production have been used in business literature since Toffler (1980) coined the "prosumer" term. Kotler (1986) described the term prosumer as "a customer who produces some of the goods and services they consume". Toffler (1980) noted an increase in people's propensity to act as a prosumer for some of the goods and services they bought (cf. Kotler, 1986). Since then, the concept of customer participation has increasingly appeared in literature. Originally literature focused on the economic implications as a result of customer participation (Bendapudi & Leone, 2003).

The prosumer concept gained ground with the rise of the Internet in the 1990s. Content was mainly the concern of professional players, and nobody questioned the fact that most of this content was produced by the same people who also wanted it – mainly the regular Internet user (Bremdal, 2011.) Tapscott (1997) reintroduced the "prosumer" to highlight the importance of this issue. Tapscott and Williams (2006) elaborated on this concept and it has since become the modern definition of "prosumption" in many ways. One of the most important additions in this concept is that of peer-to-peer communication. Previously the focus of the concept has been on the interaction between the customer and the supplier (Bremdal, 2011.) This has introduced a democratic effect in which people are empowered and allowed to actively participate in areas that were previously left to professionals (Shuen, 2008).

Although the Internet association is important, Ritzer and Jurgenson (2008) state that prosumerism is a much broader societal trend. Prosumption has become an important topic in literature only recently (Ritzer & Jurgenson, 2010). Prahalad and Ramaswamy (2004) refer to this trend under the label of "value co-creation" whereas Tapscott and Williams (2006) view the prosumer as a part of a "wikinomic" model in which firms put consumers to work.

2.2.2 Co-creation

Prahalad & Ramaswamy (2004) state that the process of value creation and the meaning of value are shifting from a firm- and product-centric view to one that is based on personalised consumer experiences. This is creating a change in how the word "market" is understood. A market can represent an aggregation of consumers. In comparison, it can be viewed as the locus of exchange where companies trade goods and services with consumers. Consumers are involved only at the end point of exchange (Prahalad & Ramaswamy, 2004.) This is represented in Figure 2.

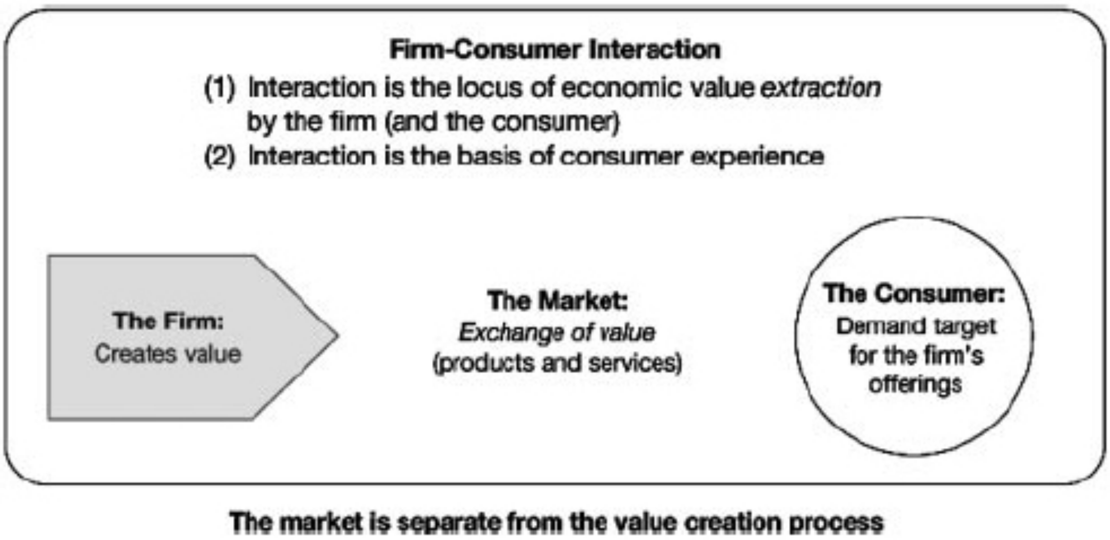


Figure 2 – Traditional Concept of a Market (Prahalad & Ramaswamy, 2004, 7)

Empowered, informed, connected and active consumers are learning that they can also extract value at the point of exchange. Consumers are putting the industry's value creation process under analysis, scrutiny and evaluation. Globalisation, outsourcing, deregulation and the convergence of technologies and industries are making the job of differentiating offerings much harder for managers. Products and services are facing commodisation unlike before. This is pushing companies to become super efficient. The traditional and distinct roles of the company and the consumer have to be challenged. The impact of the convergence of the roles of consumption and production or the convergence of the roles of the consumer and the firm should be examined (Prahalad & Ramaswamy, 2004.)

The shift from a firm-centric view towards co-creation view is not about small changes to the traditional system. Co-creation is not the outsourcing or transfer of activities to customer or the customization of products and services. Co-creation puts the focus on consumer-firm interaction as the locus of value creation. As interaction can happen anywhere in the system, the framework implies that all points of consumer-firm interaction are crucial for value creation. This places the traditional view of the market under scrutiny, as all points of interaction can be opportunities for value extraction and creation (Prahalad & Ramaswamy, 2004.) Figure 3 illustrates an emerging concept of a market.

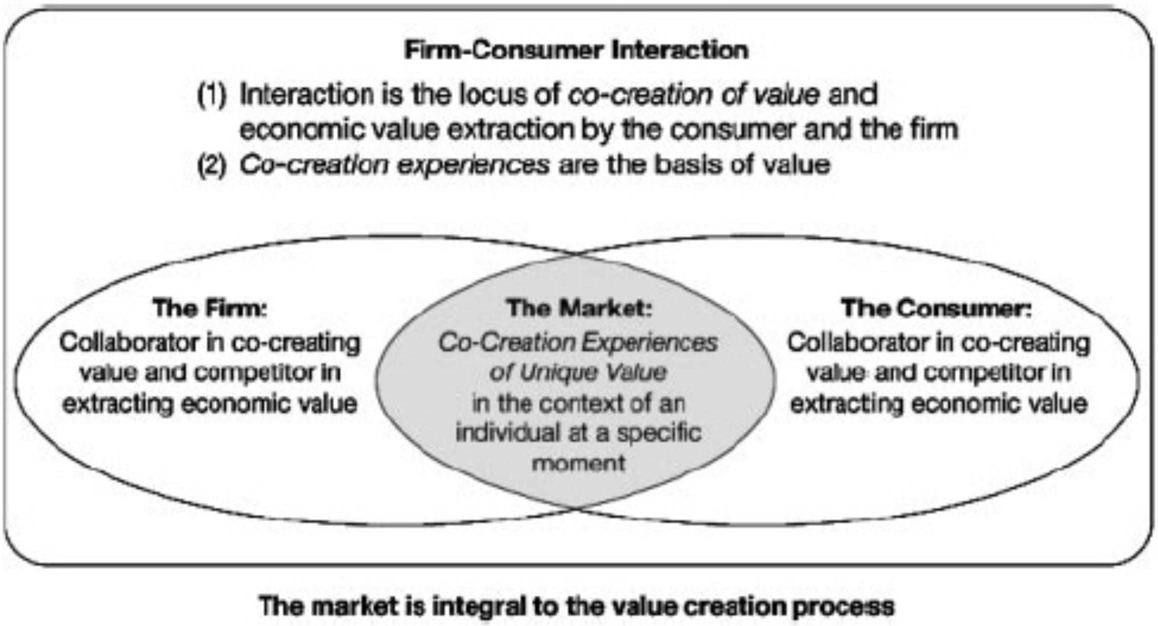


Figure 3 – Emerging Concept of the Market (Prahalad& Ramaswamy, 2004, 11)

In this emerging concept of a market the focus is on consumer-firm interaction. The roles of the firm and consumer converge in this concept. They both become collaborators and competitors. This takes form in co-creating value and competing for the extraction of this value. Co-creation turns the market into a forum where dialogueue between the firm, the consumer and consumer communities and the network of firms can take place (Prahalad & Ramaswamy, 2004.)

Value co-creation challenges the traditional distinction between supply and demand. The firm still creates a physical product; the focus however shifts to the characteristics of the overall experience. Demand becomes contextual. This new value creation frame creates new competitive space for companies. The future will belong to companies that can successfully co-create experiences with customers (Prahalad & Ramaswamy, 2004.)

Across all areas of communities, commerce and coproductive ecosystems there are underdeveloped resources. According to Shaughnessy (2015) this is leading to a dramatic shift in the way companies are interacting with their customers. Soft skills related to building ecosystems and developing communities are a core capability in "the new economy". In this new economy power is shifting to organisations that possess this engagement (Shaughnessy, 2015.)

2.3 Platforms

2.3.1 Overview

Platforms are affecting most industries today, from products to services. These platforms can be used inside companies, across supply chain, or as building blocks that foster innovation and define industrial architecture (Gawer, 2009.) Gawer (2009) states that platforms are a common feature of complex systems, whether biological or economical. These core building blocks are kept stable so the remaining parts can evolve more rapidly (The Economist, 2014.)

Although physical platforms have been around for an extended period of time, the idea didn't attract wide attention until the rise of the software industry in the 1980s and 1990s. The industry rapidly split into two sectors: operating systems (the platforms) and applications that ran on top of them. Bill Gates, the founder of Microsoft, realized the power rests with those who control the operating system (Windows). He also saw that building a thriving ecosystem was the key to creating a successful platform. The ecosystem allows networks effects to get going (The Economist, 2014.)

The concept of platform has been discussed in distinct streams of literature, including new product development, design, and operations (Meyer & Lehnerd, 1997; Simpson, T.W., Siddique, Z. &, Jiao, J., 2005); technology strategy (Gawer & Cusumano, 2002, 2008; Eisenmann, Parker, & Van Alstyne, 2006); and industrial economics (Rochet and Tirole, 2003; Evans, 2003a; Armstrong, 2006). Although the term platform is used across these distinct streams of literatures, the meaning of the term appears to differ between them often (Gawer, 2009).

Research on technological platforms bridges two theoretical perspectives: economics and engineering design. The former views platforms as double-sided markets and the latter sees them as technological architectures. The economic perspective has produced insights on competition in platforms, whereas the engineering design perspective's focus has been on platform innovation. In reality platforms often combine innovation with increased competition tensions inside their ecosystems and/or across ecosystems (Gawer, 2014.)

Gawer (2014) argues that platforms can be conceptualized as evolving organisations or meta-organisations. These organisations or meta-organisations: "(1) federate and coordinate constitutive agents who can innovate and compete; (2) create value by generating and harnessing economies of scope in supply or/and in demand; and (3) entail a modular technological architecture composed of a core and a periphery" (Gawer, 2014, 1.)

Platform firms connect distinct users in a network. Therefore they are also network firms. However, not every network or industry operates their business model as a platform firm. Platform firms provide connection and facilitate exchange between two distinct parties. This idea does not only apply to digital platforms. Transportation can be viewed as a non-digital network platform industry. Electric wire networks bring together consumers and generators in the same way (Kiesling, 2014.)

Research is often concerned with information technology industries including computing and telecommunications. These industries have visible demarcations between complements and platforms as well as strong "network effects" between these two. This leads to clear interdependencies. Platform strategies can however be pursued in many different industries. New energy sources, such as hybrid gasoline-electric systems or hydrogen fuel cells, may become platform for powering devices made by a variety of companies (Gawer & Cusumano, 2008.)

It is under debate whether all products can become platforms. Sviokla and Paoni (2005) suggest that any product, not just software, can become a platform. This requires imagination. Ignoring a product's platform potential is risky. Managers can simply overlook the platform potential of their company's products. It is difficult to create a unique product after another. The speed of product imitation is also astonishing (Sviokla & Paoni, 2005; Gawer & Cusumano, 2008.) However, Gawer and Cusumano (2008) state that not every product can become a platform. To have platform potential a product must satisfy two prerequisite conditions: (1) "it should perform at least one essential function within what can be described as "system of use" or solve an essential technological problem within an industry" and (2) "it should be easy to connect to or to build upon to expand the system of use as well as to allow new and even unintended end-uses" (Gawer & Cusumano, 2008.) Sampere (2016) makes a distinction between a product and platform: a product is "a platform that is used for one or very few products" and a platform "a structure upon which many variations of products are built". This definition takes into account the fact the definition between the two is not black-and-white (Sampere, 2016.)

Failure to decide between a platform or product strategy early on can result in strategic confusion. Achieving platform status requires a host of specific decisions that govern technology evolution as well as product and system design and relationships within the ecosystem. These are decisions that differ from those made when pursuing a product strategy (Gawer & Cusumano, 2008.)

The term platform is often used in the context of incremental innovation and new product development around reusable technologies and components. These are referred to as internal platforms. Internal platforms can be built by a firm, working together with supplier or by itself, by building sets of new features or a family of related products (Gawer & Cusumano, 2013; Gawer & Cusumano, 2014b; Gawer, 2009.)

2.3.2 Industry Platforms

The term industry platform is currently under development in academic literature. It is still under debate, whether an industry platform can be considered a business model in the same way as a multi-sided platform. Industry platforms are kept open for complementors and are not fully controlled by the platform owner. However, often industry platforms have elements of multi-sided platforms (cf. Miettinen, 2017). Gawer and Cusumano (2008) state that there is an important difference between a product and an industry platform. A product is largely proprietary and under a single company's control. An industry platform is instead a foundation technology or service that is essential for a broader and interdependent ecosystem of businesses. Therefore, the platform requires complementary innovations to be useful and vice versa. An industry platform is not fully under the control of the originator, even though it may contain some proprietary elements (Gawer & Cusumano, 2008.)

External or industry platforms are products, services or technologies, which are developed by one or more firms, and which serve as foundations for complementary innovations and potentially create network effects. These platforms provide the same kind of foundation of common technologies or components. The major differentiator is that this found is "open" to other firms. These firms can be organised as a "business ecosystem" (Gawer & Cusumano, 2014b.) The concept of industry platform shares some similarities with that of dominant design. Abernathy and Utterback (1978) state that a dominant design at its emergence sets the standard for what features and form users expect out of a certain particular product in the future.

Industry platforms do not emerge without deliberate managerial actions and decisions, or deliberate firm-driven agency. In platform markets the winner is not likely the owner of the most elegant products or the originator of the dominant design. Instead the winner is most likely the owner of the "best" platform. Gawer and Cusumano (2014) state that in successful industry platform, the use of the end service or product is not fully predetermined by the platform owner. This creates opportunity for innovation on complementary services, products or technologies. This also raises the question of how incentives to innovate can be instilled in the governance and design of the platform (Gawer & Cusumano, 2014.)

This leads to another design rule in effective industry platforms: interfaces around the platform should be "open" to allow "plug in" complements. Outside firms should also be allowed to innovate on these complements as well as be able to make money from their investments (Gawer & Cusumano, 2014.) This can be associated with research on open innovation by Chesbrough (2003) and others (von Hippel, 2005).

There are however examples of industry platforms with a varying degree of openness to outside complementors. These include: the Linux and Microsoft Windows operating systems (OS; ARM and Intel microprocessors, Apple's iPhone, iPod and iPad design with the company's iOS operating systems; Apple's AppStore and iTunes; Google's Android operating system for smart phones and Internet search engine; social networking sites such as Twitter, LinkedIn and Facebook; and the Internet itself (Gawer & Cusumano, 2014.)

Gawer and Cusumano (2014) suggest that not all multi-sided markets can be considered industry platforms. Double-sided markets that aim at facilitating trade or exchange, without other possible firms innovating on complementary markets, belong the supply-chain category. A multi-sided market that creates external innovation could in turn be regarded as an industry platform (Gawer & Cusumano, 2014.)

2.3.3 Network Effects

The driver behind the industrial economy was, and still remains, supply-side economies of scale. This means that firms with low marginal costs and massive fixed costs achieve higher sales volume than its competitors. This allows them to reduce prices, increasing volume further, permitting further price cuts. This results in a virtuous feedback loop that ultimately creates monopolies (Van Alstyne, Parker & Choudary, 2016.)

The driver behind the Internet economy, in comparison, is demand-side economies of scale. These are known as network effects. Technologies enhance networks by creating efficiencies in demand aggregation, social networking and app development. Firms that achieve higher volume in the Internet economy are those that offer greater average value per transaction. This is a result of having a larger network, which results in better matches between supply and demand. Larger scale generates more value, attracting more participants, which creates more value. This also results in a virtuous feedback loop that creates monopolies (Van Alstyne et al., 2016.)

A critical difference between internal platforms and industry platforms is the potential creation of network effects. Gawer and Cusumano (2014) define these as positive feedback loops that can grow exponentially as the number of complements and adoption of the platform rises. Network effects can be especially powerful when they are "direct" between the user of the complementary innovation and the platform. Technical standards can make switching from platform to another costly or difficult, thus reinforcing network effects (Gower & Cusumano, 2014.)

Network effects can also be "cross-side or "indirect". These can be as powerful or even more powerful as "direct" network effects. Advertisers, for example, can become attracted to a platform because of its large user base (Gower & Cusumano, 2014.) Firms can also innovate in business models and find out ways to charge different sides of the market in order to make money from the platform or from complements and different types of transactions and advertising (Eisenmann et al., 2006).

2.3.4 Multi-sided Platforms

Since the beginning of the 21st century industrial organisation economics literature has started to develop theory on platforms. These platforms have been referred to as "two-sided markets", "multi-sided markets" or "multi-sided platforms" (Rochet & Tirole, 2003, 2006; Evans, 2003; Rysman, 2009). Economics view platforms as markets that facilitate exchange between different types of consumers. These consumers would not otherwise transact with one another without the platform (Gawer, 2014.)

Two-sided markets are often referred to as two-sided networks. Two-sided networks can be found in a variety of industries sharing the space with offerings of traditional products and services. Two-sided networks differ from other kinds of offering in a fundamental way. Value moves from left to right in the traditional value chain. On the left side is cost and on the right side is revenue. In two-sided networks however cost and revenue are on both sides. This happens because platforms have distinct users on both sides. The platform can collect revenue from both groups, although one side is usually subsidized. Costs also incur in serving both groups (Eisenmann et al., 2006.)

According to Evans (2003b) multi-sided platforms can create social surplus when three conditions are fulfilled: (1) there are distinct customer groups, (2) a member of a group benefits from the coordination of demand with one or more members of another group, and (3) an intermediary can facilitate this coordination more efficiently than a bilateral relations between the members of the group. Indirect network effects often accompany the second condition and shape business strategies in these industries (Evans, 2003b.)

Evans (2009) refers to multi-sided platforms as catalysts. The value created by the catalytic reaction is crucial for understanding the feasibility of business strategies that multi-sided platforms can utilize. This value must be significant in order to warrant the risk and cost of investment in the development of the platform. Catalyst innovators are those who discover that economic value can be created by getting two or more groups of agents on a shared platform or develop a more efficient platform for initiating and accelerating a catalytic reaction (Evans, 2009.)

Hagiu and Wright (2015) state that multi-sided platforms (MSPs) have two key features: (1) they enable direct interactions between two or more sides and (2) each side is affiliated with the platform. Direct interaction refers to each side retaining control over the key terms of the interaction. Affiliation refers to each side of the platform making platform-specific investment in order for each side to directly interact with one another. These investments can include fixed fees, expenditure of resources or opportunity costs. These dimensions help distinguish MSPs from other related but distinct business models. Figure 4 outlines this distinction.

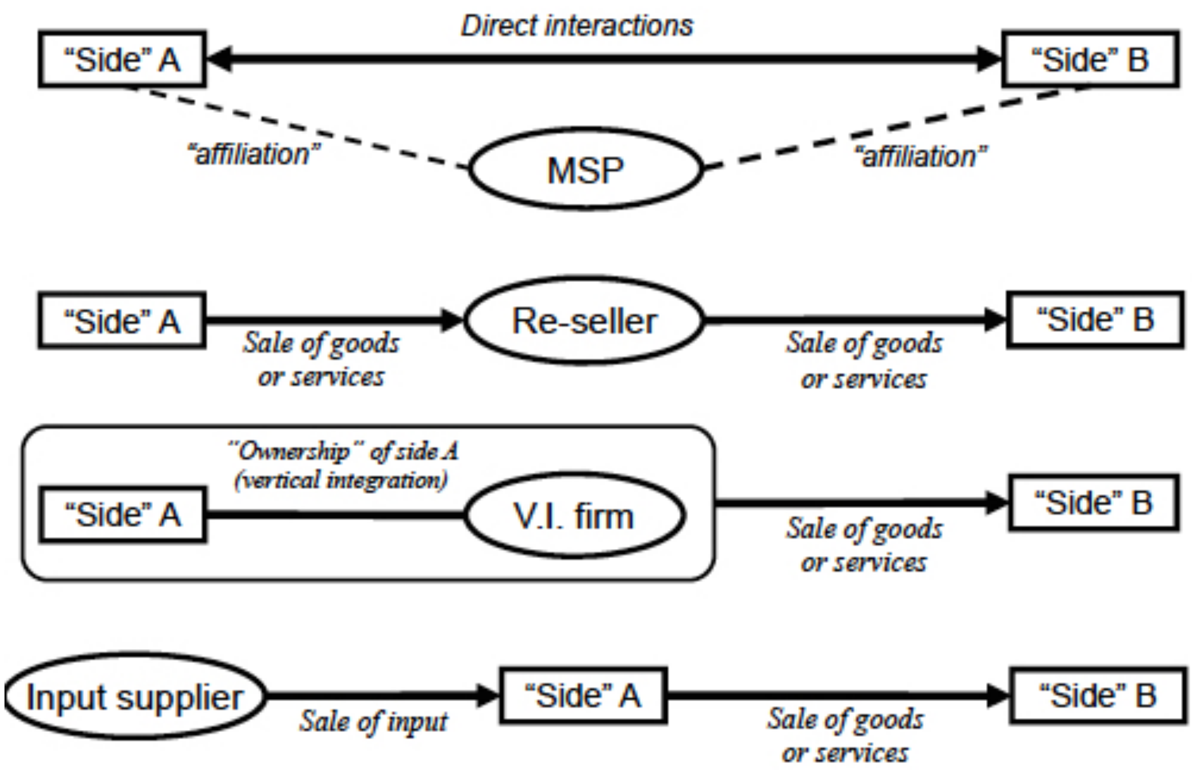


Figure 4 – MSPs vs. Alternative Business Models (Hagiu & Wright, 2015, 165)

Direct interactions between different sides set MSPs apart from fully vertically integrated firms and resellers. Affiliation by all customer types (sides) helps separate MSPs from input suppliers that are not adopted by all customer types. Affiliation by multiple sides is required for MSPs to create cross-group network effects. This definition also takes into account the focus of existing definitions focusing solely on indirect network effects (Hagiu & Wright, 2015.)

2.4 Platforms and Disruption

2.4.1 Disruptive Platforms

The economy is in the midst of reorganisations. Platform owners are developing power that might be more formidable that the power of factory owners of the early industrial revolution. While there is rich and emerging literature on platforms, there is no real theory of the effect that these diverse platforms will have on the overall economy. However, these platforms are in many cases changing the logic of value creation and value capture, resetting entry barriers, repacking work, playing regulatory arbitrage or repositioning power in the economic system. Platform companies have become disruptive. Online platforms have already upended various brick and mortar chains and are making way into other industries from transportation to television (Kenney & Zysman, 2016; Gawer and Evans 2016.) Shaughnessy (2015) states that platforms differ in their scale and scope from what the advice given to companies in the past has been: closely stick to core competencies.

Shaughnessy (2015) describes ways in which the disruption effect pulls down the barriers of vertical industries (e.g. telecoms). This creates a more democratized business environment and drives opportunity horizontally for small firms and individuals. This effect is not just commercial, but normative – driven by people who wish to see business conducted differently. The disruption effect reduces the barriers for market entry. It allows competitors to enter in the customer relationship and application spaces and creates and ease of access. This effect is also cumulative. Even though it took fifteen years to change telecoms and IT sectors, the disruption effects spread because both are horizontal industries. It also allows for utilities to develope based on ecosystems and platforms (Shaughnessy, 2015.)

Disruption can be separated into three different types based on Clayton Christensen's (1997, 2014) definitions – high-end disruption, low-end disruption and new-market disruption (Sampere, 2016; Bergius, 2012). High-end disruption enters a market with a platform or product that is superior compared to incumbents' offerings, whereas the low-end disruption offers a platform or product that is simpler to use or more affordable. New-market disruption emerges from non-consumers and creates a new category or even a new industry. New-market platform-based disruption creates new categories, but also allows new populations to make money. There is a big difference with whether an organisation starts with a platform or product. Platform-based disruptions have an effect inside the industry as well as outside its boundaries, whereas the product-based disruptions have "within the industry" effects (Sampere, 2016.)

Sood and Tellis (2011) identify three domains of disruption. In each of these disruption can occur independently: technology, firm and demand. Technology disruption arises when new technology exceeds the performance of the dominant technology based on the primary dimension of performance. Firm disruption arises when the market share of a company whose products use new technology surpass the markets share of the largest company whose products use highest-share technology. Highest-share technology refers to technology with the highest market share during the time when new technology is introduced in the market. Demand disruption takes place when the total share of products based on dominant technology is exceeded by the market based on new technology (Sood & Tellis, 2011.) All of these three domains of disruption can be applied to platform disruption (cf. Miettinen, 2017).

It is important to understand to understand how platforms become disruptive and what are their effects. To say that the Internet or digitization causes them does not address the causal roots. There are a variety of descriptions of how system-level transitions take place (Shaughnessy, 2015.):

1) Kondratieff (1925) explained that disruption occurs in sixty year cycles (waves) during which commodity prices become too high for incumbents to sustain and therefore radical innovation is needed.

2) Schumpeter (1942) suggested that capitalism would become increasingly corporatist, making entrepreneurism impossible. This would lead creative destruction, an ideological attack on capitalism.

3) Clayton Christensen (1997) described disruption as a process of smaller companies with low cost products attracting low-end customers. These companies would compete by changing market structure, meanwhile gaining experience and changing customer needs and the basic conditions of the market.

4) Downes and Nunes (2013) have described a new form of disruption that they refer to as Big Bang. Big Bang disruptors can be strategically incompetent and accidental, but still very powerful.

5) The fifth school of thought has been given less attention to. This refers to Klepper and Simons' (1997) work on new entrants to a market sector and firm survival.

Klepper and Simons (1997) found that sectors and firms tend towards an oligopoly. They observed that these firms gradually reduce the number of competitors and become members of a smaller group of survivors. They will remain in this as they keep barriers to entry high. Oligopolies also make it difficult to respond to competitive pressure due to their complex decision processes (Klepper & Simons, 1997.) Based on Schumpeter's (1942) thinking it is possible to introduce a five-step process that prompts structural disruption that affects all companies in a sector: concentration and hubris, the experimental era, the new content layer, ecosystem consolidation and platform. This process describes the move from existing market structure towards a durable start-up community and the arrival of a platform company. This platform creates severe horizontal pressure and initiates multiple random adjacencies (Shaughnessy, 2015.)

The classical definition of disruption that views companies as being hit by low-cost disruption requires the higher specification product to be unsatisfying. In this sense, disruptors create new markets. Disruption today is a result of new business philosophy, cheaper business infrastructure, a new commercial structure and devolution of risk towards self-determining entities that are organised around platforms (Shaughnessy, 2015.) The new wave of platform-based disruptive organisations will not only change industries but will also drive a deeper societal change (Sampere, 2016).

Shaughnessy (2015) states that successful platforms offer more than connection – they create utility value. Utility value can be a product, service, connection, reputation or any value that fulfils a sentient need. The ecosystem and platform model does not rely on network effects. The platform is a medium for creating utility value by bringing people together on a broad scale (Shaughnessy, 2015.)

2.4.2 Platform Value Development

Theories of vertical and horizontal expansion can be compared with those of internal and industry platforms. This outlines a distinct way of examining a company or industry's development. Platforms provide entirely new ways of creating and capturing value. Under a strictly vertical structure value is added along the value chain to be consumed by the consumer. This is where internal platforms can drive for economies of scale. Internal platforms serve as drivers of incremental innovation and product development based on reusable technologies and components (Gawer & Cusumano, 2014). This can be compared to the traditional strategy of vertical integration where companies are pushing for backward or forward integration.

Industry platforms instead serve as foundations for complementary innovations and may potentially create network effects (Gawer & Cusumano, 2014). Expanding in the value network of the industry platform can therefore mean the move towards complementary or adjacent activities. Industry platforms open up horizontal space for complementary or "outside-industry" development much like a value network expands potentially creating networks effects (cf. Gawer & Cusumano, 2014).

Platforms provide rules and infrastructure for a market place that brings together consumers and producers. These players fill four roles, but may rapidly shift between roles. Owners of the platforms control governance and their intellectual property. Providers serve as the platform's interface alongside users. Consumers use offerings created by producers. Value and data is exchanged through the platform along with feedback between producers and consumers. Figure 5 outlines the players in a platform (Van Alstyne et al., 2016.)

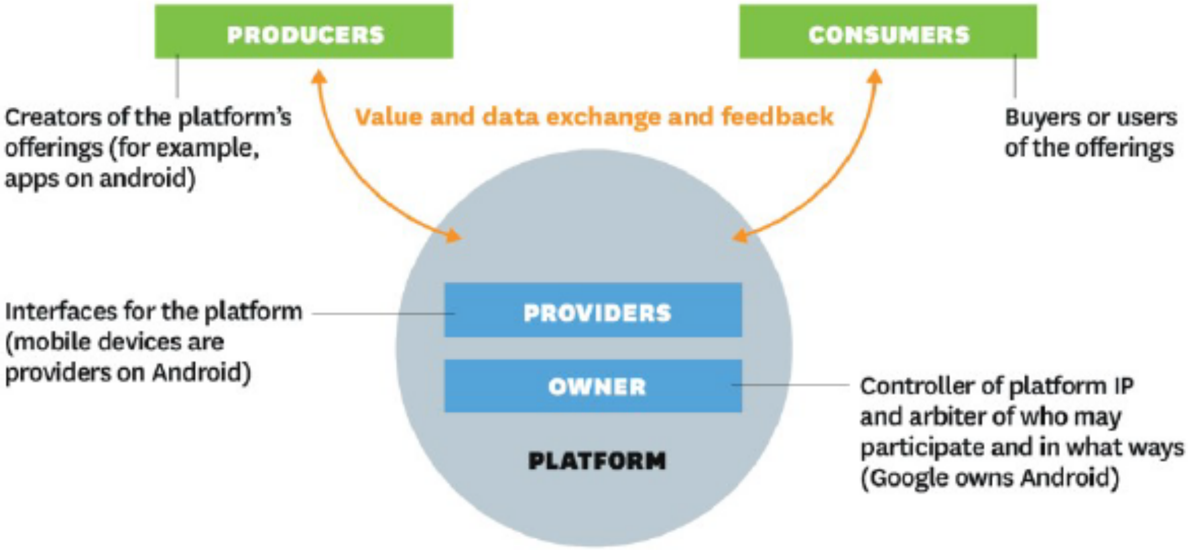


Figure 5 – Platform Players (Van Alstyne et al., 2016, 4)

External forces are often seen as "depletive” thus extracting value from a firm. This is an argument for building barriers against such forces. In demand-side economies, however, these external forces can be "accretive". These forces therefore ad value to the platform business. The threatening power of customers and suppliers in the supply-side world may be seen as an asset on platforms. It is central to platform strategy to understand when external forces add or extract value in an ecosystem (Van Alstyne et al., 2016.)

Van Alstyne et al. (2016) state that in order to understand how platforms are transforming competition, we need to understand how platforms differ from the conventional "pipeline" businesses that have dominated for decades. Pipeline businesses create value by controlling a linear set of activities – the traditional value chain model. The move from pipeline business to platforms involves three key shifts (Van Alstyne et al., 2016.):

1) **From resource control to resource orchestration.** This view on competition is based on resources. Firms that control scarce and valuable assets gain advantage over competitors. In a pipeline world, these tangible assets include real estate and mines and intangible assets including intellectual property. In platforms, assets that are hard to copy are the community and the resources its members contribute and own. The network of producers and consumers is the chief asset.

2) **From internal optimization to external interaction**. Pipeline firms organise internal resources to create value by optimizing the entire chain of product activities. Platforms create value by facilitating the interaction between its external producers and consumers. The emphasis thus shifts from directing processes towards persuading participants. Ecosystem governance becomes an essential skill.

3) **From a focus on customer value to a focus on ecosystem value**. Pipelines look to maximize the lifetime value of individual customers of services and products. These customers are in the end of the linear process. In comparison, platforms look to maximize the total value of growing ecosystem. This happens in a circulatory, iterative and feedback-driven process.

These shifts exemplify that competition is more dynamic and complicated in a platform world. Platforms that enter a pipeline organisation's market almost always win. In order to manage competitive forces executives have to play attention to participants' access, interactions on the platform and new performance metrics (Van Alstyne et al., 2016.)

2.4.3 New Platform Development

If a platform leader emerges they can form an "ecosystem" of innovation by working with companies supplying complementary products and services. Companies however often fail to turn their products into platforms in their selected industry. "Platform-leader wannabes" face special problems. Many companies fail because they cannot adequately tackle both the business and technology aspects of platform leadership. Business challenges include: making key complements or establishing incentives for companies to create complementary innovations required to build market momentum and defeat competing platforms. Technological challenges include designing the right architecture, disclosing property selectively and designing right interfaces, in order to facilitate third-parties' provision of complement (Gawer & Cusumano, 2008.)

Gawer and Cusumano (2008) identified four mechanisms or "lever" through which platform leaders could "architect" or influence external innovation. The first one was company scope. This is the choice of what activities to leave to other companies versus what to perform in-house. The second lever was intellectual property and technology design: what features or functionality to include in the platform. Questions regarding this factor include: should the platform be modular, to what degree should the platform interfaces be open and at what price. The third lever focused on the external relationships with competitors. This covered the process by which the platform leaders pursued to manage complementors and how it encouraged them to contribute to the ecosystem. The fourth lever was the internal organisation. How and to what extent should the platform leaders use their internal processes and organisational structure to give assurance to complementors, so that they are genuinely working towards the overall good of the ecosystem (Gawer and Cusumano, 2008.)

Kenney and Zysman (2016) state that many platforms by nature prove to be "winner-take-all markets". In these markets only one or two companies survive and the owner of the platform can appropriate a generous of the overall value created by all the users on the platform. As power is decentralised the platform owner can become a virtual monopolist. Thiel (2015) states that monopoly is the condition of every successful business. We live in a dynamic world. Creative monopolists give customers more choices by creating entirely new categories. Creative monopolies are not only good for the society, but they are powerful engines that make it better (Kenney & Zysman, 2016; Thiel, 2015.) This development can lead to a similar oligopolistic structure as before the disruption, but with a different market structure with different firms and more choice for the customer.

2.5 Ecosystems

2.5.1 Overview

Moore (1996) suggests that the term industry should be replaced by the term business ecosystem. The reasoning behind this is due to the inability to divide certain economic activities under specific industries. Business ecosystems are based on core capabilities. These are exploited in order to produce the core product. A customer receives "a total experience", in addition to the core product, which includes different types of complementary offers (Moore, 1996.)

Ecosystems present a change in classic business metaphors that revolve around warfare. Ecosystems are a natural phenomenon. They generally viewed as stable systems, which make them seem idyllic for self-adapting organisms. Life itself is exemplified by rapid change. This sense of change is important in business ecosystems, especially when change in the future is likely to occur more frequently. The natural ecosystems metaphor signifies the ultimate competition and mutual dependency that occurs in natural ecosystems. Business ecosystems should not be confused with a view of the soft and organic image of ecosystems. Ecosystems are tough places. Simultaneously, they offer a possibility for efficient growth for the owner of a platform (Shaughnessy, 2015.)

Moore (1996) defines the business ecosystem as "an economic community supported by a foundation of interacting organisations and individual – the organisms of the business world." According to Moore (1996) a business ecosystem includes customers, competitors, lead producers and other stakeholders. Leadership companies are key to business ecosystems ("the keystone species"). These firms have a strong influence on the co-evolutionary processes. These are just metaphors that can help in clarifying and understanding certain issues (Moore, 1996.) Peltoniemi and Vuori (2004) state that Moore's definition of the business ecosystem is closer to the concepts of value network and cluster.

Since then Moore has developed his definition of the business ecosystem. Moore (1998, 168) states that a business ecosystem is an "extended system of mutually supportive organisations; communities of customers, suppliers, lead producers, and other stakeholders, financing, trade associations, standard bodies, labour unions, governmental and quasigovernmental institutions, and other interested parties. These communities come together in a partially intentional, highly self-organising, and even somewhat accidental manner." The first definition underlines interaction within the business ecosystem, whereas the second one highlights decentralised decision-making and self-organisation (Peltoniemi & Vuori, 2004).

Gossain and Kandiah (1998) build upon Moore's (1996, 1998) definition by emphasising the role that the Internet can have in the networked information economy. They recognise the importance of value creation for customers through the provision of addition information as well as goods and services. They also only include partners and suppliers in the business ecosystem and state that the "connectivity between them is the engine at the heart of the whole system" (Gossain & Kandiah, 1998, 2.) They associate business ecosystems with integrated value chains (Gossain & Kandiah, 1998).

Iansiti and Levien (2004) use the business ecosystem as an analogy, which can help in understanding certain issues. "We found that perhaps more than any other type of network, a biological ecosystem provides a powerful analogy for understanding a business network. Like business network, biological ecosystems are characterised by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival. And like business network participants, biological species in ecosystems share their fate with each other. If the ecosystem is healthy, individual species thrive. If the ecosystem is unhealthy, individual species suffer deeply. And as with business ecosystems, reversals in overall ecosystem health can happen very quickly" (Iansiati & Levien, 2004, 8-9). The features of a business ecosystem include cooperation, competition, fragmentation and interconnectedness (Iansiti & Levien, 2004).

Iansiti and Levien (2004) note that there are differences between business and natural ecosystems. First, players in business ecosystems are intelligent and capable of planning and seeing the future. Second, businesses compete over potential members. Third, business ecosystems aim at delivering innovations, whereas natural ecosystems aim at pure survival (Iansiti & Levien, 2004.)

There is a theoretical lack of definition in the concept of business ecosystem. It is often associated with similar concepts (e.g. industrial ecosystem and digital business ecosystem). It is important to discuss how far an analogy can be stretched (Peltoniemi & Vuori, 2004.) Lewin and Regine (1999) state that business ecosystems do not just resemble natural ones, but also share some fundamental properties. Peltoniemi and Vuori (2004) state that this view implies an elevation of the analysis to the level of fundamental mechanisms.

Peltoniemi and Vuori (2004) consider a "business ecosystem to be a dynamic structure which consists of an interconnected population of organisations". These organisations can be large corporations, small firms, public sector organisations, research centres, universities and other parties that influence the system. The business ecosystems can be defined as consisting of one or more organisations based on different research. Peltoniemi and Vuori (2004) state that a business ecosystem contains a population of organisations.

2.5.2 Ecosystem Development

Business ecosystems permeate, surround and reshape hierarchies and markets. Managers establish ecosystems in order to coordinate innovation over complementary contributions rising from multiple hierarchies and markets. The activities of business ecosystems create the agenda for the co-evolution of hierarchies and markets along with their outputs. The focus of companies in a majority of sectors has progressed beyond competition on effectiveness and efficiency towards competition based on continuous innovation. Companies have also discovered that one company cannot change the world. There are complementary innovations for every advance. These must be joined for customers to benefit. Complementary advances must therefore co-evolve across company boundaries (Moore, 2006.)

Business ecosystem-based economic organisations and the related strategy making are not limited to the high technology sectors of computer and communication technology. Instead the concept has now spread across industries from retail and fashion to energy and oil production (Moore, 2006.) The joining of two foundation infrastructure sectors (telecommunication and information technology) will create new business platforms that are becoming the utilities of the twenty-first century. This new model will expose the economy to three distinct horizontal disruptions: "the spread of mobile connectivity across all industries and a business anywhere, anytime logic; a platform and ecosystem model of business organisation; and a rapidly changing financial environment". These horizontal pressures will disrupt industries from pharmaceuticals to energy and utilities (Shaughnessy, 2015.)

A business ecosystem can be conceived as a network of interdependent niches. These niches are occupied by organisations. Each niche can be viewed to be more or less open, based on the degree to which they accept alternative contributors. Business ecosystems can be "opened up" to the whole world of potential creative participants and contributions (Moore, 2006.)

Business ecosystems develop through co-evolution, emergence and self-organisation. These help it to acquire adaptability. Both cooperation and competition are present in a business ecosystem simultaneously. By treating business ecosystems as complex adaptive systems, their evolution, formation and interdependence can be understood in a broader context and research made in other sciences can be exploited (Peltoniemi & Vuori, 2004.)

Iansiti and Levien (2004) propose four types of roles that organisations can take in a business ecosystem. Keystones companies serve as enablers and have a great impact on the system as a whole. These companies, however, constitute a small number of the whole system. Niche players in turn are the biggest group in the business ecosystem. Hub landlords and dominators are organisations that attract resources from system, but do not work reciprocally (Iansiti & Levien, 2004.)

Previous literature on ecosystems has stressed the role of the co-opetition element – cooperating with competitors in order to reach mutual gains. This interpretation is valid in many large industry ecosystems that rely on expensive and complex technologies (e.g. mobile microprocessors). Inside these ecosystems a common platform can embed and develop experience. Ecosystems thus become a way around the work that a standards' process would require from all participants. In essence, they accelerate innovation much like platforms. Today's ecosystems almost always have a commons at work, which develops some element of a product in a non-proprietary and open environment (Shaughnessy, 2015.)

Concepts like "open", "free" and "commons" are critical in today's ecosystems. These are part of a broader move towards a commons that is hedged partly by large organisations. This moment is characterised as being partly free, partly owned and partly wild. The new ecosystems will likely provide lower guarantees of returns for its participants than previous business approaches. However, intercompany ecosystems with broad-based collaboration are accelerating business velocity and replacing formal standard setting in the market (Shaughnessy, 2015.)

2.6 Framework for this Study

Key themes examined in this theory Chapter include value development, co-creation, platform and ecosystem theory. The theory section builds from a smaller-scale view of value development and co-creation towards bigger layers in the overall ecosystem. Platforms are closely related to ecosystems and even used synonymously in literature. Figure 6 comprises the outcome of the theoretical part of this study to create a theoretical framework.

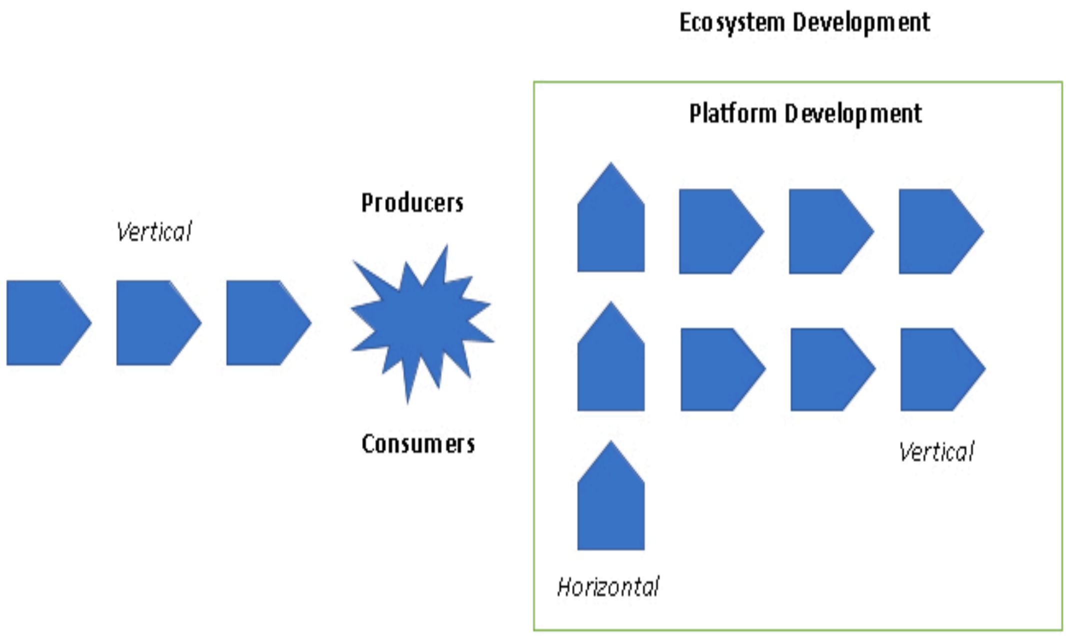


Figure 6 – Theoretical Framework

The vertical structure of organisations and industries was the starting point for the theoretical Chapter. This has been the dominant structure in capital intensive and heavy industries, especially in the utility industries. The theory section outlined a framework that examines how these vertical structures are being challenged.

Producers and consumers are colliding in a process that results in co-creation. Co-creation is a strong force that needs a unique structure to facilitate exchange. This creates a whole new market between the firm and the consumer. This can also be referred to as a platform market, more specifically, a multi-sided platform that facilitates exchange between individuals turning the role of the traditional consumer towards a prosumer-based role. This enables new business opportunities and new forms of value creation.

These platform markets begin to open up space in vertical industries and create horizontal pressure in a process of platform disruption. This creates potential for the creation of an overall ecosystem. As more and more is being exchanged in the system, the ecosystem becomes broader. Platforms can offer value in the same as vertical structures, but they can also expand to other areas. Platforms begin to expand horizontally as they advance to adjacent areas.

The result of these horizontal forces is a broader ecosystem that creates and adds value in completely new ways based on platforms. Control of this process is not entirely possible by any one platform. This takes focus away from individual organisations towards a broader view based on individuals and collaboration. The ecosystem unites individual prosumers and outside-industry players to collaborate and exchange value. Focus ultimately shifts away from a strict industry-based view to one based on broad horizontal platforms.

3 METHODOLOGY

This research project has been inspired by the researcher's keen interest in technological development in the electric power industry and as a result of working professionally in the field. My work experience has provided a unique viewpoint into the development of industry. Chapter specifies the methodological choices made in conducting the research and discusses how data was gathered, analysed and interpreted. This Chapter will also provide insight into the validity, reliability and the limitations of this study.

A study may provide new information through deductive (theory-guided) or inductive (content-guided) reasoning. Deductive reasoning is formed through hypotheses and their testing through the lenses of previous theories. Empirical research develops through gathering different material and interpretation towards forming theory (Ghauri & Grønhaug, 2010; Saunders, Lewis & Thornhill, 2009). According to Eriksson and Kovalainen (2008) it is common for a study to contain elements of deductive and inductive logic. Figure 7 outlines this combination of approaches.

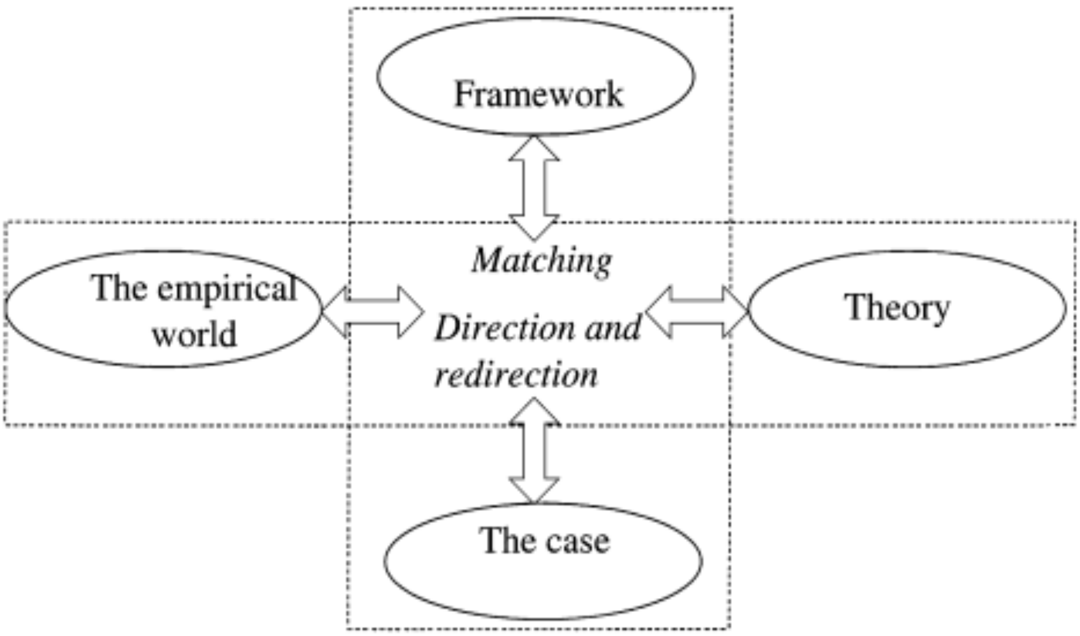


Figure 7 – Systemic Combining (Dubois & Gadde, 2002, 555)

This research represents abductive logic, involving both deductive and inductive reasoning processes, as is the case in most of social research (Eriksson & Kovalainen, 2008, 21). According to Dubois and Gadde (2002) abductive research aims towards dialogue between theory and observations, and the combining of these observations. This is referred to as systemic combining, where dialogue between theory and empirical observations extend through the whole research process (Dubois & Gadde, 2002). Deductive reasoning was used to take previous theories of value development, co-creation, platforms and ecosystems to further understand how co-creation opens space for platforms and ecosystems. The theoretical framework was used in inductive reflection of the empirical research to develop the theories further based on the findings. Thus, the study aims to develop an understanding of platform and ecosystem development in the electric power industry.

3.1 Research Method

The qualitative and quantitative methods are often described as opposites, but this can lead to oversimplification. Instead these two should be seen as complementary. The quantitative approach uses statistical methods or other methods of quantification, and can therefore provide results, which can be generalized (Ghauri & Grønhaug, 2010, 104). In comparison, the qualitative approach represents a more holistic interpretation and understanding and provides the possibility to explore a field that is not yet well defined (Eriksson & Kovalainen, 2008, 5; Ghauri & Grønhaug, 2010, 109-110). This is a result of the researcher´s interaction in qualitative research with the object of research (Hirsjärvi & Hurme, 2011, 23-24). Thus, choosing a qualitative approach does not exclude the possibility of using numerical data in the research.

This study adopts the basic ideology of qualitative case research. Qualitative research is used in sciences that study human beings. Its purpose is to under the phenomenon that is being researched. Understanding refers to acquainting oneself with the emotions, thoughts and motives of research subjects (Tuomi & Sarajärvi, 2009.) Qualitative research can constitute compelling arguments about how things work in a particular context (Mason, 2002). The object of study may be a company or environment (Koskinen, Alasuutari & Peltonen, 2005), individual (Eriksson & Kovalainen, 2008), or an individual event (Yin, 2009). The qualitative approach allows addressing the complexity of a business-related phenomenon, in this case the transformation of the dominant vertical electric power industry (Eriksson & Kovalainen, 2008, 3).

Yin (2009, 18) defines a case study to be an empirical inquiry, which: "investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident, copes with the technically distinctive situation in which there will be many more variables of interest than data points and as one result, relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis." (Yin 2009, 18.)

The case study was selected as a researched method due to its fit with the aim of describing and analysing the transformation of the electric power industry. This study is an intensive case study, as it explores the development of the chosen industry and its environment (Eriksson & Kovalainen, 2008, 118-120). Multiple smaller case studies are however presented in Chapter 5 to further deepen understanding of the transformation occurring in the electric power industry. In a single case study, the main objective is to understand the particular case well. The focus is on particularization not generalization (Stake, 1995, 4, 8.) A case study is not a data collection method, but rather a research approach that pertains the way of generating conclusions (Koskinen et al., 2005, 154).

This research represents both an instrumental and descriptive case study. According to Eriksson and Koistinen (2005) the instrumental case study should be chosen when the case has an instrumental role in revealing something additional through it. A descriptive case study includes the understanding of processes and its different stages and events. In a descriptive case study the theory is useful if it helps in producing a valid explanation for the case. If the theory does not succeed in explaining the case, it should be developed further or re-designed by the researcher (Eriksson & Koistinen, 2005.) The complexity of the constantly evolving electric power industry meant that the material and its relevant theories were put under constant reflection.

3.2 Data Collection

Typical features of qualitative research are: comprehensive collection of information from real and natural situations, people as the preferred source of information, the use of qualitative methods in data gathering, the use of inductive analysis, selecting the units of analysis by rationalizing instead of a random sample, handling the cases as unique and interpreting the results accordingly (Hirsjärvi, Remes & Sajavaara, 2009, 161-165).

The empirical evidence of this study was gathered from various sources. Data for this research report comes from both primary and secondary data. According to Eriksson and Kovalainen (2008, 77-78) primary data is empirical data collected by the researcher themselves. The primary has been gathered mainly through interviews. The secondary data refers to already existing empirical data from various previous research reports, industry literature and public material from companies. The aim was to apply the triangulation of data, where evidence is gathered from multiple sources to crosscheck the information (Eriksson & Kovalainen, 2008, 292-293.)

Data on the dominant vertical electric power industry structure was mostly gathered from existing material available on the subject. This was done to provide a background and develop an understanding on the dominant logic and structure of the industry. This data was examined in detail and formed the basis for Chapter 4.

Data on the development of the electric power industry, the technology-driven horizontal forces and the effects of these drivers was gathered mainly from expert interviews. This allowed for a more through and detailed understanding of the industry and its potential future development. The interviews were focused on the future development of the industry and less on the current structure and business logic. The data from the expert interviews formed the basis for Chapter 5.

The interviews were carried as semi-structured interviews. The semi-structured interview was chosen as the data collection method as it allows the interviewee to more freely express his or her points of view (Koskinen et al., 2005, 104). This is important as the research aims to understand the underlying phenomenon. Semi-structured interviews allow the detection of issues that are not prevalent in literature (Erikkson & Kovalainen, 2008, 82). The importance in semi-structured interviews is in the themes not in the questions (Hirsjärvi & Hurme, 2011, 48).

As the study aimed for a better understanding of the development occurring in the electric power industry, interviewees were chosen from different companies, roles and functions. Interviews were held through October 2016 to January 2017 in Finland. Table 1 outlines details of these interviews. The interviews lasted for 1-2 hours. A semi-structured interview structure was developed (see Appendix 3).

Table 1 – Interviewees

Timo Honkanen	Turku Energia	CEO	26/10/2016
Jaakko Aho	AC2SG	CEO	3/11/2016
Joni Markkula	Virta Ltd	Project Manager	11/11/2016
Karoliina Auvinen	Smart Energy Transition	Stakeholder Relations Manager and Researcher	5/12/2016
Olli Kananen	Virta Ltd	Business Developer	13/1/2017

Discussion followed the themes in the interview outline. This gave interviewees space to express their views. This allowed for specifying questions that spurred as a result of the discussion. The order and focus of the themes varied between the interviews based on the flow of the discussion. These are typical issues for semi-structured interviews. The most important aspect was to make sure that all topics in the outline were covered (Eriksson & Kovalainen, 2008, 82).

3.3 Data Analysis

The interviews were recorded with the consent of the interviewees. The recordings formed the basis of the primary data. Each recorded interview was transliterated word-by-word. Altogether this provided over 40 pages of interview material. After dissembling the interviews I analysed the material content with content analysis methods as systematically and objectively as possible. According to Kyngäs and Vanhanen (1999), with content analysis the gathered material and studied phenomenon can be organised, described, or quantified. The purpose of the analysis is to build models that depict the described phenomenon in a condensed form that allow the phenomenon to be conceptualised.

The pattern matching technique was utilised in analysing the primary data from the interviews. In this technique, patterns are found from the empirical data and are then compared to the pre-developed propositions on the basis of existing theory. If the patterns coincide, the results can help a case study to strengthen its internal validity (Yin 2003, 116 – 120.) In this research report, the findings from the primary data (interviews) were crosschecked with findings from the secondary data (previous literature and research) and theory on value development, co-creation, platforms and ecosystems.

The analysis started by thoroughly reading the transcripts of the interviews. The units of analysis were categorised according to the theoretical foundation and key research questions of this study. As patterns and analysis units began to emerge they were divided into categories. These categories were then compared to the pre-developed propositions from the secondary data. Arguments were used together with the findings from the secondary data in the empirical findings of this study. The empirical findings were then reflected to the theories value development, co-creation, platforms and ecosystems. Results were described in the findings and conclusions part of this research report.

3.4 Validity and Reliability

Validity can consist of a variety of aspects. Yin (2009, 40), for example, divides it to construct validity, external validity and internal validity. In this study I aim to construct validity by using two different kinds of sources of information – primary and secondary data. Internal validity is related to the data analysis, which was discussed in detail in Chapter 3.3. This study can be viewed deficient in external validity is that it focuses on only one broad industry.

An issue concerning the internal validity of this study is the fact that primary data was collected through interviews. This can result in human errors for both participants – the interviewer and the interviewee. A person views the world through symbols and his or her values and beliefs as well as being subject to the socially constructed culture and reality (Hirjärvi & Hurme, 2011, 16-17). This can result in a biased way of thinking. Concepts of validity and reliability suggest that there exists an objective truth that can be studied (Hirjärvi & Hurme, 2011, 185). However, this is ultimately not possible to achieve. It is possible that findings of this study could have differed if other interviewees had participated.

Hirsjärvi et al. (2009) state that the accurate description of how the research has been conducted enhances the reliability of qualitative research. Circumstances of the data gathering should be explained in full detail. For example, the observations and the timings and the places of the interviews should be explained clearly. According to Stake (1995), the case will never be seen in the same way by everyone involved. Therefore, discovering and portraying the multiple views of the case is crucial. Mason (2002) states that the qualitative research should be accountable for its claims and quality. Thus, it should not attempt to position itself outside judgment and should provide its audience with material upon which they can judge it. I strived to provide as much material and explanations about the methodological choices in this study, to meet these requirements for qualitative research. The circumstances of the data gathering were described in full in Chapter 3.2.

3.5 Limitations

As this study has been conducted based on a qualitative single case study design, there are multiple limitations in the generalization of the results. The focus of qualitative research is in revealing and finding issues rather than proving already existing statements (Hirsjärvi et al. 2009). The single case study aims to catch the particularity and complexity of a single case coming to understand its activity within important circumstances (Stake 1995, xi). This research report aims to understand the forces of technology-driven horizontal pressures on the dominant vertical electricity platform. Further research is needed to find out, if the results of this research report can be generalized.

The topic of this research report is the holistic description of the shifts in the dominant vertical electric power industry as a result of technology-driven horizontal pressures. By looking at the dominant vertical structure, this research report covers the whole value chain of the industry. Due to the broadness of the topic, the research has certain limitations. This report focuses on the industry as a whole and not on any individual players in it. Focus is on the dominant vertical model of the industry in mature markets (i.e. North America and Europe). All markets are different and under constant development. However, this approach provides an overall understanding of the changes impacting the industry.

4 THE DOMINANT VERTICAL ELECTRIC POWER INDUSTRY

4.1 Background

"The difficulty lies, not in the new ideas, but in escaping from the old ones."

- Keynes, 1936

In order to understand the electric power industry, it is important to understand the earlier development of the industry and its dominant business logic. The electricity industry is not a likely candidate for disruption. Significant change has not happened between the 1880s, when Thomas Edison began building power stations and the beginning of the 21st century. Business leaders and consumers had to rarely think about energy. It was delivered by the local utility or by the government (Schiwieter & Flaherty, 2015.)

The first great business model innovation in the electric power industry occurred a century ago when the move from small local plant to central generating plants began. The small plants delivered power over short distances whereas the central generating plants delivered power for great distances over high-voltage wires. In the early days of the electric power industry the structure and system for delivering and generating energy was integrated and highly localized. This innovation was followed by a period of "grow-and-build" philosophy. The practical limit of this philosophy was reached during the end of the 20th century. However little evolution of business models has occurred since the "grow-and-build" years (Valocchi et al., 2010.)

Electric utilities pursued a "grow-and-build" strategy from the early times of the integrated monopoly utility until the late 1960s. This was driven by economies of scale as well as the development of the steam engine at the turn of the 19th century. Investments were based on a CAPEX calculation (Valocchi et al., 2010; Aho, 2016.) The cost of generating electricity declined, as a result of new turbines and their greater output and lower cost-per-unit output. Customers were encouraged to increase their use of electricity to reach these economies of scale benefits. Economies of scale eventually plateaued as generating units reached their optimum size by the early 1970s. In today's capital and carbon-restricted environment utilities are encouraging customers to use less energy in order to avoid setting up new infrastructure (Valocchi et al., 2010.)

It is, however, incorrect to state that the electricity grid has stood still – it has continued to evolve to meet growing demand and address risks. Risks range from minor outages to rare massive blackouts. The historic design of the grid however places it at risk of disruption. Just-in-time production and the dependence for balancing grid voltage are drivers behind this view. These factors also place constraints on the grid's economic potential as new threats emerge and complexity increases. The grid has even been viewed as a model of reliability. Changes in the design are therefore often met with scepticism. Carvallo & Cooper (2011) state that the industry has yet to embrace lessons learned from the Internet. They suggest a new architectural model to meet the needs of the new century (Carvallo & Cooper, 2011.)

4.1.1 Industry Value Chain

Despite minor differences in local circumstances, the power grid is operated almost the same way everywhere. Thus, it is important to understand the different entities the form the value chain of the electric power sector. The value chain can be roughly split into five parts – power generation, transmission, distribution, retail and end-consumer (Rodríguez-Molina, Martínez-Nuñez, Martínez & Pérez-Aguiar, 2014.)

Generation

Power generation has to be understood as turning raw energy into electricity. High-scale power plants account for the major share of produced energy. These power plants are highly dependent on nuclear energy or fossil fuels (Rodríguez-Molina et al., 2014.)

Transmission/Distribution

The transmission system is designed to deliver electricity produced in central production locations to a large number of locations. The transmission system operator (TSO) is the entity responsible for providing the grid infrastructure used to transmit this electricity. This is usually achieved by covering sections where high voltage power is required. In addition, the TSO is in charge of demand/offer balance of electricity in its chose area. The distribution system operator (DSO) is responsible for insuring all end-user connectivity features to the power network (Rodríguez-Molina et al., 2014.)

Retail/End-consumer

The electricity retail controls the low voltage power that is transferred to its point of use. This entity is responsible for purchasing electricity, along with metering and billing. The last link in the value chain is the end-consumer (Rodríguez-Molina et al., 2014.) Traditionally the end-user has been a passive player in the industry (Valocchi et al., 2010).

4.1.2 Integration and Deregulation

Traditionally, the power sector has been defined by a stable legal framework and mature technology that guaranteed profitability (Deloitte, 2015a). Energy utilities operating in the electricity sector have historically been vertically integrated. This is partly due to the need for coordination in production characterized by their technology. This need is evident in the case of electricity – its nature as a non-storable good makes it necessary to achieve a balance between demand and production constantly. This is probably more achievable under a structure that is vertically integrated. The recent regulatory tendency is pushing for vertical unbundling of the distribution and transmission network. On the production side the scalability of technology already allows the presence of multiple competitors. Transmission and distribution still display natural monopoly features (Bruno, 2011.)

The deregulation of the energy markets has taken place over the past 30 years. Deregulation first started in North America and then moved to Europe (Walsh & Todeva, 2005.) The current situation of competition and integration differs from region to region depending on market growth and the state of regulation. In mature markets characterized by slow growth, competition is usually at a high level. This is the case in the United States and in many European Union countries (Deloitte, 2015a.) In these relatively open markets the transformation of the industry value chain will have a greater impact (cf. PwC, 2016a)

Until recently, most power utilities were vertically integrated holding generation, distribution and retail services inside one business. Deregulation changed this and separated the value chain into separate organisations. Regulators were hoping to release the same kind of innovation and fluidity that portrayed deregulation in telecommunications. Walsh (2005) states that the intent of deregulation was to push for market segmentation based on quality, technology, price or scale or scope economies. Due to a variety of reasons, the sector didn't see the same kind of profit-generating innovation. Whereas telecom innovations dramatically increased the use of their services, this was not the case for power utilities. The efforts to increase energy efficiency might not be desirable (Gottfredson et al., 2013.)

After seeing few benefits of taking apart the value chain, many utility executives are considering the benefits of vertical integration once again. Vertical integration can offer advantages – access to shifting profit pools, reduced exposure to market volatility and a bigger customer base. Gottfredson et al.'s (2013) analysis however shows that this is sometimes the case, but often it is not. Different capabilities are required on different parts of the industry value chain. In order to answer the question of potential reintegration utilities must first create "a company that is better equipped to deal with the broad trends facing the energy sector". These trends include: greater competition, investments in smart grids and renewables, stagnating demand and distributed generation (Gottfredson et al., 2013.)

According to Carvallo & Cooper (2011) the traditional utility silo-model (generation, transmission, distribution, retail) is not suitable for the dynamic change driven by new technologies. To cope with these changes utilities should transition away from their traditional silos. They should shift their business models more towards services and less in the direction of selling a commodity based on kilowatts-per-hour. They must also adapt at the technology level along with a new IP network architecture that can cope with these new technologies (Carvallo & Cooper, 2011.)

4.2 The Electricity Network as a Platform

The electricity network has operated as one of the earliest technology platforms. The electric power sector has served as an early platform industry. The dominant design has been based on scaling the production and integrating an increasing amount of customers into the same platform. This platform has traditionally operated as a single-sided platform. Ownership of the entire value chain meant that businesses owned the whole platform and controlled the entire process. Independent generators and energy retailers moved the network towards an intermediator role, transporting power from wholesalers to customers (Valocchi et al., 2010.)

It has become evident that there are major forces affecting the electric power industry. Historically the sector has operated under a vertical structure. This has provided customers with a reliable and cost-effective way to receive electricity. Concerns about the climate, customer demand and technological development are putting this traditional structure under question. There is a need for the sector to develop new models in supplying, storing and distributing energy.

New technologies present a significant potential for transformation in the industry. The vertical structure and dominant one-sided platform is reaching its limit. The "grow-and-build" strategy is coming under question as new advances in technology are providing new means of structuring the electricity value chain. Centralized power plants and the strictly vertical model of the electric power sector may not be the only viable option for producing and distributing electricity in the future.

5 HORIZONTAL DRIVERS OF DISRUPTION

5.1 Key Technological Drivers

Historically, technology adoption has been slow in the power utilities sector. There has been relatively small amount of change in the grid and centralized generation model. Key technological developments have taken 10 years or more to become established. Companies are not used to the fast-moving technology adoption that characterize the digital communications sector. Unsurprisingly, utility and power companies are reporting to be struggling with technological breakthrough, especially at the customer-end of the value chain (PwC, 2016a.) The traditionally "linear" businesses (i.e. energy) need to adapt towards a growing pace of exponential change. This change is being driven by exponential technologies deployed on the entire energy value chain (Deloitte, 2016.)

According to PwC (2016b) more innovation will occur in the next 20 years in the utilities sector than has occurred since the time of Thomas Edison. The speed of change driven by technology is accelerating at a pace previously impossible in the electric power sector. The utilities sector is set to develop very different business models, customer platforms, performance roles, and technology landscapes than those that served it for the first century (PwC, 2016b.)

Technological innovation is at the centre of the shifts that are signalling the prospect of a very different future for the electric power industry. The increase of solar and wind generation is one of the most clear manifestations of these shifts. Advances are however occurring in many other parts of the sector as well – on the load side, in smart grids, in small-scale and distributed customer-based energy systems, and large-scale technologies including DC transmission. These shift in power technology are occurring simultaneously with the digital revolution. This is opening up new and easier ways of managing, controlling and trading energy (PwC, 2016a.)

Electricity has traditionally been viewed as a scarce resource, but new technologies are challenging this view. By enabling consumers to become producers, there can be large-scale changes in the structural design of the electric power sector. The potential shift can be seen as a democratization of the energy commodity (cf. Accenture, 2015).

5.1.1 Cost-effective Renewable Energy Resources

Cheaper gas and coal will not hinder the transformation towards decarbonisation in the world's power systems. Bloomberg (2016) estimates that by 2040 zero-emission sources will account for 60% of installed capacity. Of this figure solar and wind will make up 64% of the estimated 8.6 TW of new power generating capacity installed worldwide in the upcoming 25 years (Bloomberg, 2016.) Figure 8 represents the unsubsidized level cost of energy (LCOE) for these two energy sources in the United States.

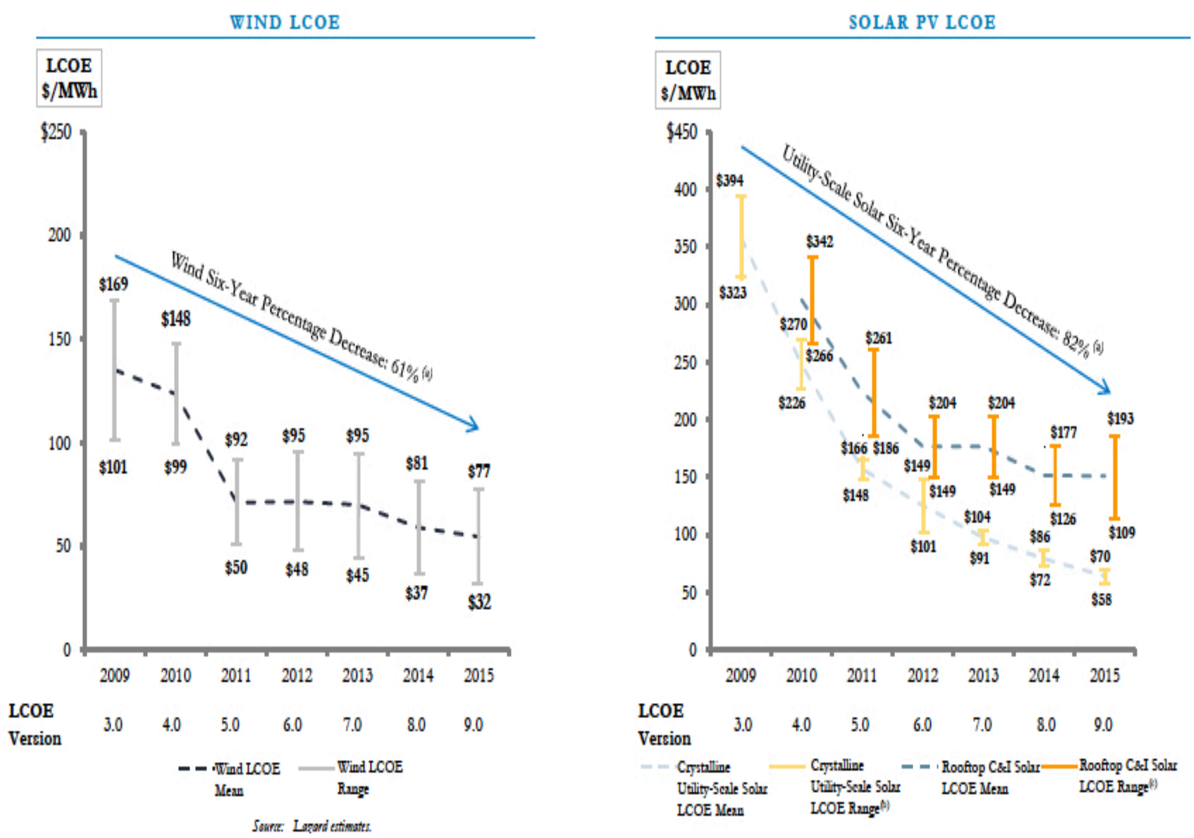


Figure 8 – Unsubsidised Levelised Cost of Energy – Wind/Solar PV (Historical) (Lazard, 2015, 10)

The price of wind and solar is on a downward curve. These technologies have become increasingly cost-competitive on an unsubsidised basis. This has been achievable through dramatic improvements in efficiency as well as decline in the prices of system components. These figures do not account for environmental or social externalities or associated reliability issues (Lazard, 2015.) This illustrates the nature of these technologies compared to other energy sources. They are widely production-based and can thus benefit from economies of scale. Convential energy sources (i.e. gas or coal) are instead more sensitive to changes in the price changes in the underlying resource. Appendix 2 shows how these alternative resources compare with conventional energy resources.

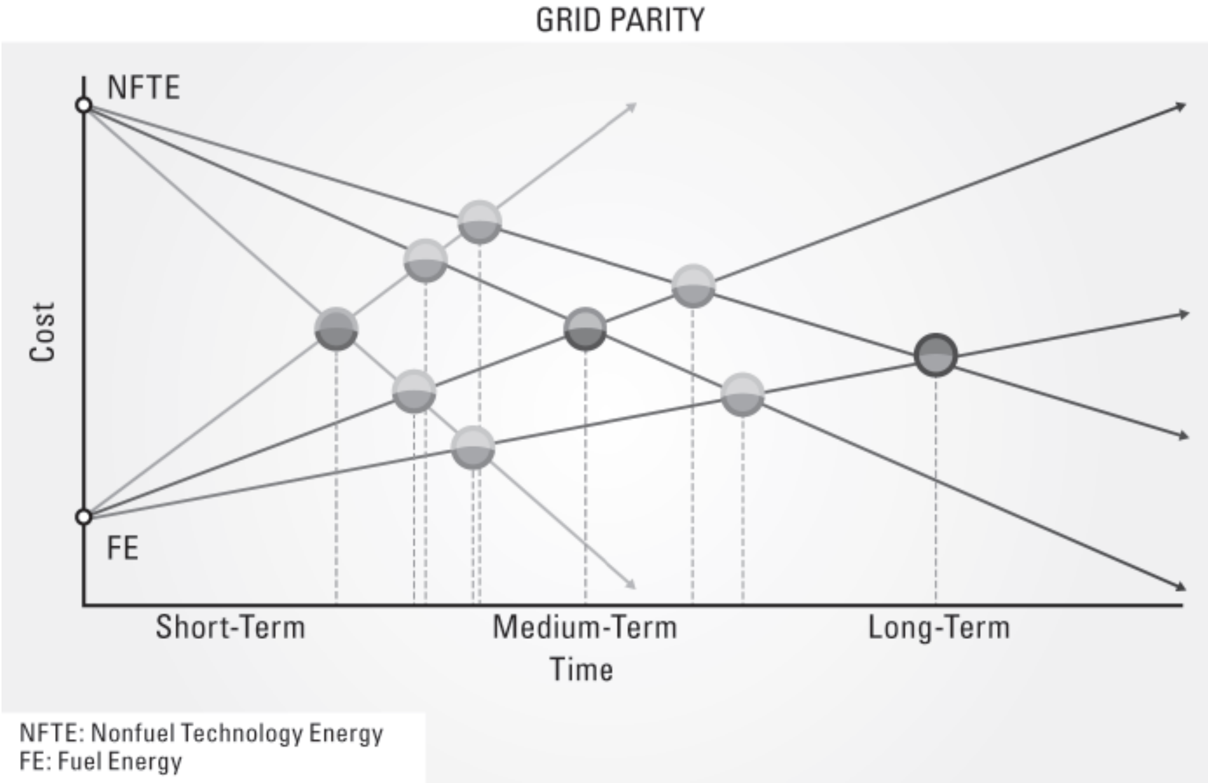


Figure 9 – Nonfuel Technology Energy Versus Fuel-based Energy (Carvallo & Cooper, 2011, 204)

Carvallo & Cooper (2011) state that the nature of nonfuel technology (NFTE) is to become cheaper over time (see Figure 9). This is achieved through scale production of materials and devices, innovation and distributed electricity delivery through edge-based processes and services. Fuel-based energy (FE) has also decreased as a result of scale production and innovation, and it is likely to continue. Looking forward, increased demand for these resources and resource constraints will drive up the cost of fuel-based energy (Carvallo & Cooper, 2011.)

Grid parity is a term often linked with renewable energy resources. It refers to point where renewable energy resources are price-competitive with conventional energy resources. Local subsidies can however have an impact on the competitiveness of these technologies and grid parity. The unsubsidized cost of rooftop solar is $0.08-$0.13. This is 30-40% below the retail price for electricity in many markets worldwide. Out of 60 countries studied in Deutsche Bank's Solar Report roughly 30 countries have regions that are at grid parity for solar (Deutsche Bank, 2015.) According to Deloitte (2015b) three converging trends are pushing development of renewable energy forward in the United States: wholesale power market rebalancing, forecasted rising natural gas prices and on-going improvements in renewable technology. Deloitte (2015b) expects onshore wind to reach grid parity (without subsidies) before utility-scale solar photovoltaics, based on a wide range of assumptions.

As seen in Appendix 2 these alternative energy sources are becoming increasingly cost-competitive with traditional energy technologies especially on the utility-scale in the United States. Grid parity is well established for both of these energy sources. We are nearing a point where their growth will become market-driven instead of subsidy-driven. Due to economics becoming attractive on both large and small scale, an increasing amount of businesses and households are deciding to generate electricity on their own (PwC, 201a.)

Vandebron – Peer-to-peer Energy Marketplace

"The sharing economy is coming to the power industry. In the future, we may buy energy from each other, just as we now rent homes from each other on AirBbnB." - Schiller, 2014

Vandebron (translation: "from the source"), a start-up from Netherlands, is bringing together consumers and producers of electricity through its website. The consumer buys electricity directly from independent producers. Utilities are not included in the transaction in any way. Farmers with wind turbines on their fields can sell their excess electricity through Vandebron's website. Wind energy accounted for 89,13% of total electricity sold in 2015 through Vandebron. Other energy sources include bioenergy (0,49%) and solar energy (0,38%). Currently the company only operates in the Netherlands, where the energy market is fully deregulated (Schiller, 2014; Vandebron, 2016.)

According to Vandebron both consumers and producers benefit from their service. Producers can get a better rate per unit as they are not forced to accept rates set by utilities. Each source also namely supplies the national grid. This means the supply of electricity will not be interrupted as consumers get energy from the same network. Consumers also avoid the mark-up utilities charge for distributing that power. Consumers pay exactly the price set by the producers. Vandebron's current subscription fee is 6.25€ per month much like the subscription fee on music service Spotify for example. Vandebron currently serves over 80,000 households in the Netherlands (Schiller, 2014; Vandebron, 2016.) Figure 10 illustrates Vandebron's pricing compared to that of traditional energy companies.

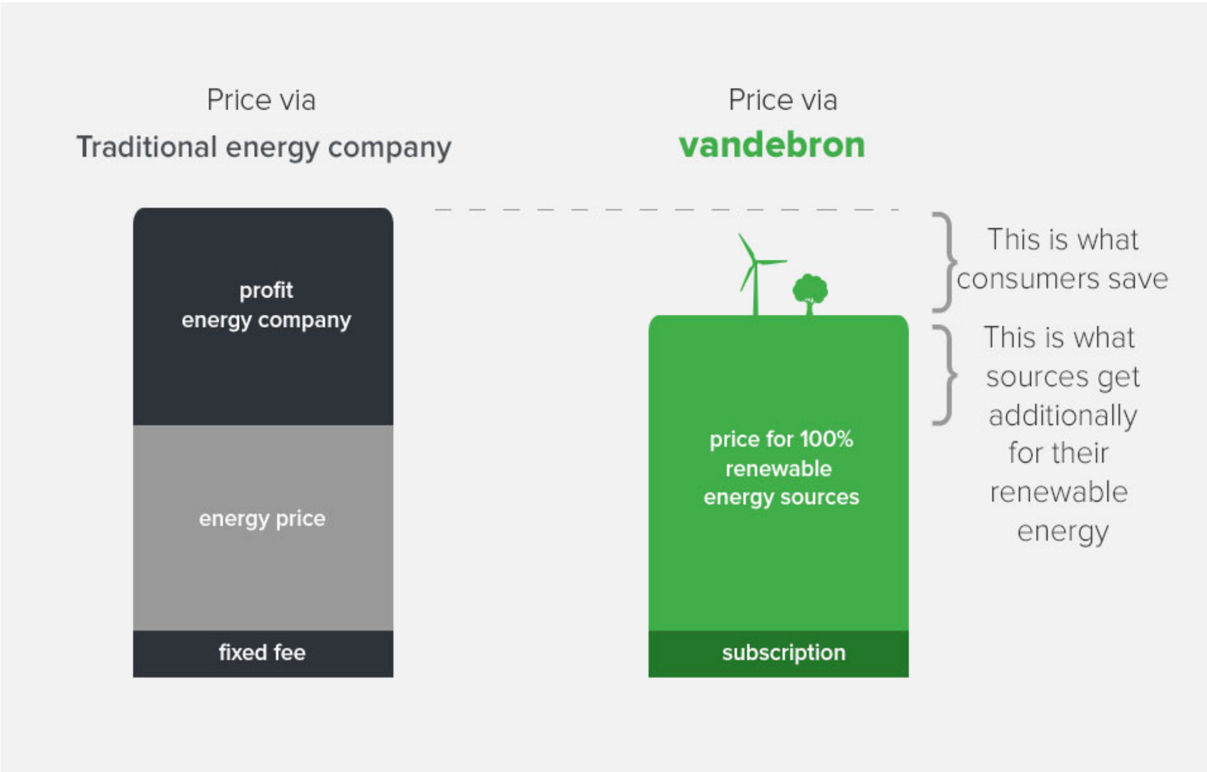


Figure 10 – Vandebron Pricing (Changemakers, 2016)

Traditional energy companies are not suited to providing renewable energy. This is mainly due to their legacy investments in fossil fuels. Utilities also have an interest in selling more units of electricity. This is not good in an efficiency point of view. Vandebron's interest is aligned with that of their customer's with their flat subscription fee. When customers use less energy, the company signs up more new customers for each of its producers. This increases the subscription fees received by the company (Schiller, 2014; Vandebron, 2016.)

5.1.2 Energy Storage

Energy storage is making its way back to the power sector. Battery storage was an integral part of the power grid 120 years ago. Many distribution networks and central power plants relied on battery systems in the late 19th century (Gluski & Shelton, 2016.) Historically, bulk energy storage came in the form of pumped hydro. This was used to replace costlier natural gas peaking stations and to store excess energy from coal generation (PwC, 2016b; Honkanen, 2016.)

Energy storage is needed to compensate for the time lag between times that renewable energy is available and times at which it is needed. Batteries are the most popular of these systems. Battery devices are relatively efficient and technically suited for small-scale distributed generation that is based on renewables. Others systems include: pumped hydropower, flywheels, compressed air storage, electrochemical capacitors, and superconducting magnetic energy storage (Shandurkova et al., 2012.)

Although historical activity has centred on pumped hydro storage, new interest focuses on advanced storage technologies. Investments running in the billions have been made into lithium-ion batteries, thermal batteries, other types of chemical batteries, and physical storage technologies (e.g. flywheels and compressed air). This is resulting in cost reductions and accelerating performance (PwC, 2016b.) Figure 11 illustrates battery price projections based on data available from the U.S Energy Information Administration (EIA), Bloomberg New Energy Finance and Navigant Research.

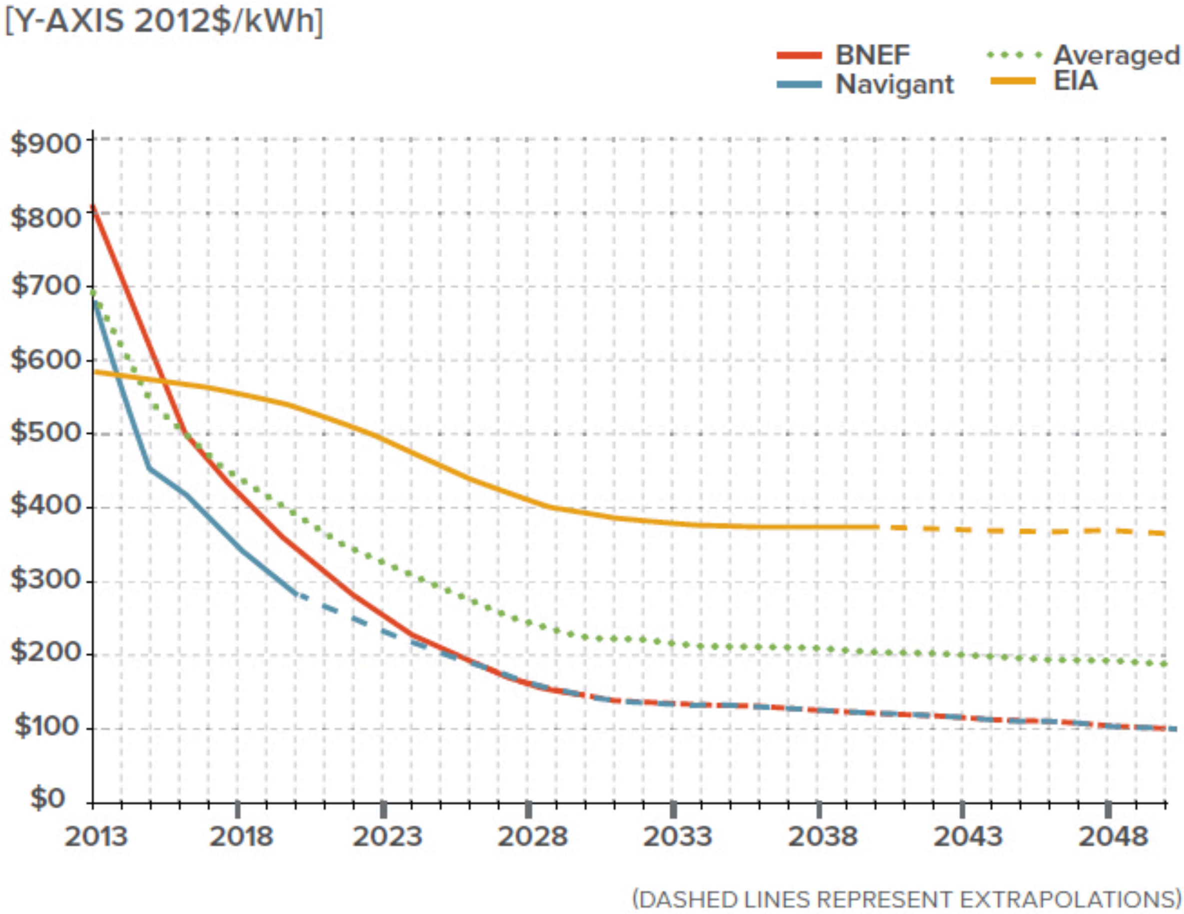


Figure 11 – Battery Price Projections (Rocky Mountain Institute, 2013, 24)

Due to uncertainties in scale economies and technology, the cost curves for energy storage vary widely. Optimists draw analogies from the cost evolution of silicon solar costs. On the other hand the high proportion of rare earth materials used in batteries is seen as a constraint for cost-reduction. Commercial viability also varies by the desired application (capacity market participation vs. price arbitrage vs. frequency regulation). Innovation is however occurring in the optimization of lithium-ion and flow battery technologies along with the identification of new battery chemistries (PwC, 2016b.) Breakthroughs in energy storage could become a real tipping point. The viability of large-scale renewable energy would be given a boost in national power systems. Simultaneously it would alter the economics of local energy systems and self-generation, while reducing reliance on the central grid (PwC, 2016a.)

Tesla Powerwall – Energy Storage

The Tesla Powerwall is a home battery that charges using electricity either from self-generation by solar panels, or when utility rates are low. Simultaneously it provides the customer with backup electricity supply against power outages. It is automated, compact and simple to install. The Powerwall offers independence from the electricity grid and offers security of an emergency backup (Tesla Motors, 2016a.)

The Powerwall stores electricity generated by solar panels and makes it available in the evening, when electricity is needed. The gap between peak solar and peak demand can be therefore bridged with the product. Combining solar panels with one or more Powerwalls can power a home independently from the grid. This can result in a net zero energy rating, where a home produces as much energy as it consumes (Tesla Motors, 2016a.) Battisti and Giulietti (2015) state that "the Powerwall is first battery on the market to provide a solution to solar energy storage that is simple to use, easy to install, relatively inexpensive to maintain, and more aesthetically appealing than existing home batteries and storage systems, such as small diesel generators." The product has the characteristics required to succeed in this market (Battisti & Giulietti, 2015.)

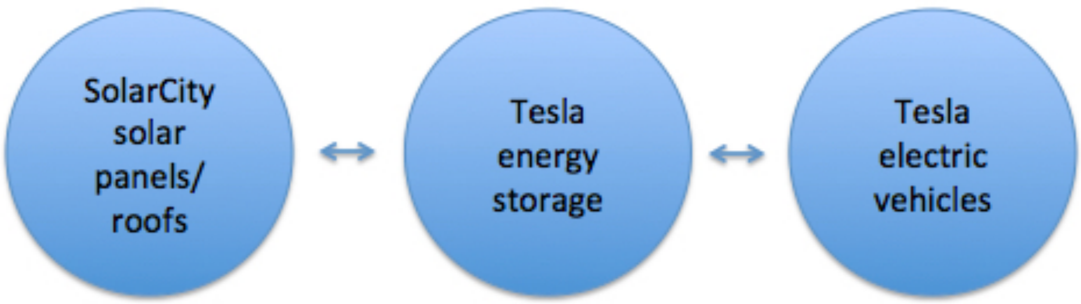


Figure 12 – Tesla Synergies

Tesla's offering ties into SolarCity’s offering (see Figure 12). Rooftop solar and electric vehicles are two very different products. However, the two companies have a mutual interest in the development of energy storage. Battisti and Giulietti (2015) state that it is not always the best technology that wins the innovation race. Instead, it is often the one that fits well with the existing dominant technologies, so that the two can be come interrelated. By spreading together these two technologies could ultimately become a new technical standard in the majority of businesses and households. Alongside the large-scale battery factory, Gigafactory, SolarCity has announced their plan to start large-scale production of solar panel in Buffalo, New York (Battisti & Giulietti, 2015.) Sampere (2016) defines Tesla's battery as a product. But with the introduction of more electric cars in the market and a broader use for rechargeable electric batteries, the battery may perhaps eventually "scale to become more like a platform" (Sampere, 2016).

The broader play may not be to supply battery hardware into the residential market. Instead, the Powerwall can be viewed as an anchor for a Tesla home energy ecosystem. Tesla is transforming itself into an energy provider. Consumers are able to purchase an electric vehicle, electric vehicle charging, battery storage and solar panels. In October 2016 Tesla debuted the Powerwall 2 model and SolarCity's solar roof. Tesla's acquisition of SolarCity was also finalized in November 2016. The customer can be therefore seen as buying into a platform, the way that Mac users buy into Apple's ecosystem (Dehamna, 2015; Tesla, 2016b.)

5.1.3 Distributed Energy Resources (DERs)

Distributed energy resources (DERs) are premise-based systems that manage, produce and/or store power on the edges of the power grid. The main categories of DER include the following: distributed generation, electric vehicles and energy storage systems (Carvallo & Cooper, 2011.

Distributed generation (DG) includes any edge-based electricity producing devices or technologies. These devices or technologies are defined by their greater number but smaller capacity compared to traditional power plants. The most popular DG example today is that of rooftop photovoltaic (PV) solar systems – consisting of inverters, net meters and the solar PV panels (Carvallo & Cooper, 2011.)

Small-scale and rooftop solar installations are one of the first technologies that have become a cost-effective microgeneration solution for both commercial and residential consumers. The cost of producing, installing and managing these panels has dropped exponentially in recent years. This has meant that certain geographies have reached grid parity (Accenture, 2014.) DG also offer many advantages compared to traditional production units: less up-front capital, easier to match supply and demand, ability to install quickly, better level of control and operational advantages for the grid (PwC, 2016b).

Electric vehicles (EVs) include hybrid electric and fully electric vehicles alongside electric charging stations and their respective support networks. These charging stations are most likely to be deployed at business and residences as well as public locations (Carvallo & Cooper, 2011.) According to Technavio's (2015) report global electric vehicles sales are expected increase tenfold from 164,000 units in 2014 to 1,695,000 units in 2019. This growing focus on EVs is driven by both demand and supply side factors. These factors are changing the equation on performance, price and value (PwC, 2016b).

Energy storage is becoming available on all levels – premise, community and utility. According to Carvallo & Cooper (2011) the main distributed energy storage in the near future is likely to be community energy storage (CES). CES is capable of serving multiple co-located business or residences and is midrange in size (Carvallo & Cooper, 2011.)

The significant feature of these products is that they are offered straight to the end-user – thus creating edge empowerment. Technological progress has previously pushed more communications and computing capability to the edge, and now the same phenomena is also occurring in energy technology. This change has been recognised widely by Moore's law. In addition to Moore's law, Metcalfe's law is associated with the Internet and telecommunications levels. This law suggest that the "value of a network is proportional to the square of the number of nodes on that network". This means that the network becomes increasingly more valuable as more devices added. The valuable of the network is a result of having an increased number of connections (Carvallo & Cooper, 2011.)

These laws have significantly affected the computer and telecommunications industries. Mainframes and central switches were not completely eliminated when distributed options came online – focus however shifted towards the distributed edge. It is not hard to imagine that today's central power plants could begin to lose their dominance as more distributed generation and storage options are made available and made online. These trends are fundamentally based on digital and network maturity: increasing mobility and computation leads to greater enablement at the edge (Carvallo & Cooper, 2011.) Figure 13 outlines a shift towards edge empowerment through technology development.

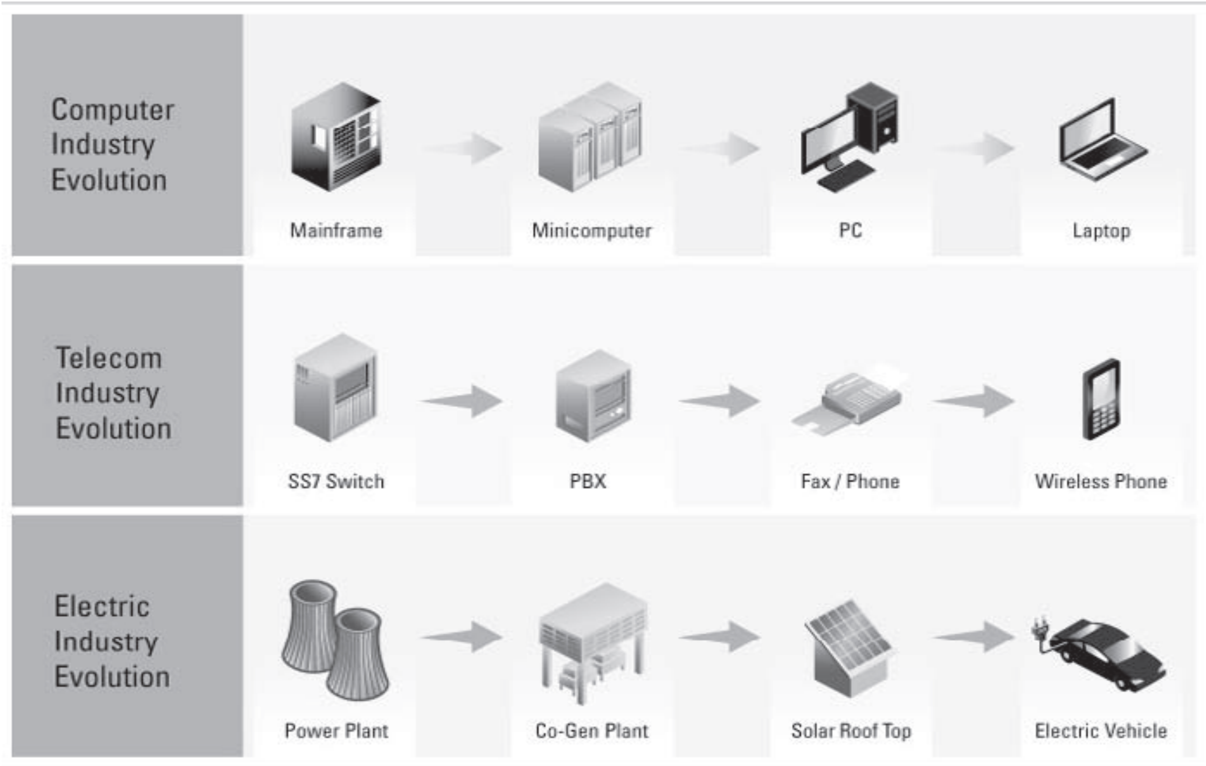


Figure 13 – The Drive to Edge Empowerment (Carvallo & Cooper, 2011, 7)

sonnenCommunity – Decentralised Energy Community

"The real solution is to build large-scale capacity at utility grade by aggregating those individual rooftop solar + storage systems." – Sunverge, 2016

A German company, Sonnen, launched its sonnenCommunity electricity platform in December 2015. Sonnen is a supplier of storage systems. Their platform allows customers to connect with each other in real time. One customer can send feed in their power and another can take it out simultaneously through the grid. Extra power is therefore not supplied to the grid. This can be achieved by smart software together with smart meters (Colthorpe, 2015.) Sonnen will serve as the umbrella brand as a part of this new business model. The community will feature three key technologies battery energy storage, decentralised power generation and digital networking supported by a self-learning software platform (Meyers, 2015.) Figure 14 illustrates how sonnenCommunity is organised.

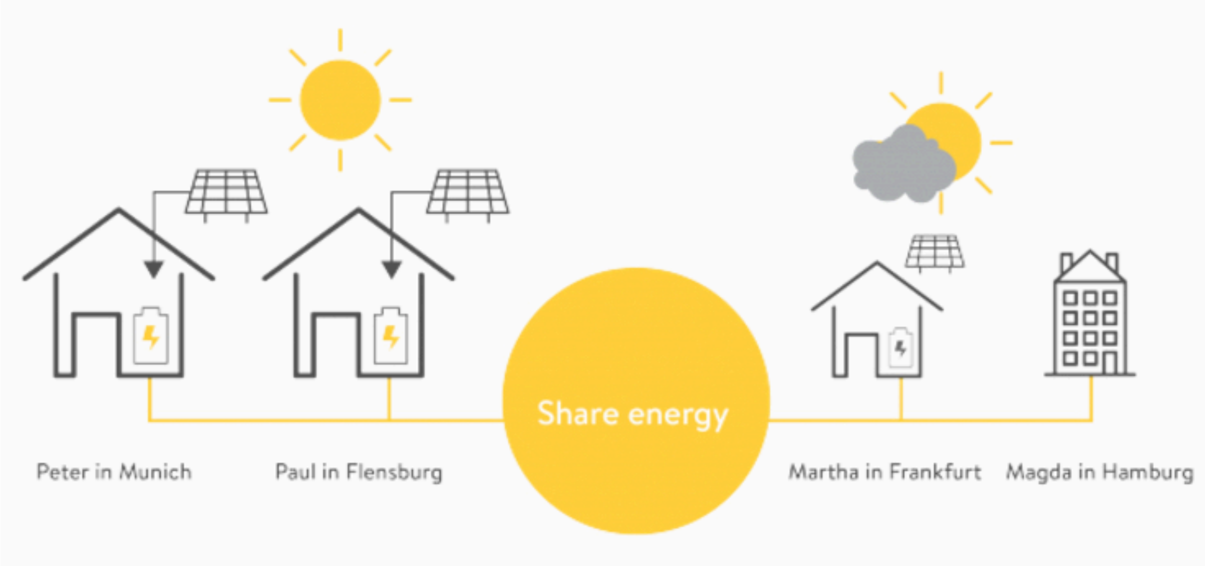


Figure 14 – The sonnenCommunity (Sonnen, 2016)

The sonnenCommunity is a community of sonnenBatterie owners. Members of the community can share their self-produced energy with other members of the community. Exclusive use of the community's energy means that there is no need for a conventional energy provider. The surplus of energy is not fed into the traditional power grid, but instead into a virtual pool. This pool serves the other members of the community in times when they are not able to produce energy (Sonnen, 2016.)

The trading system is available for anyone on the German grid via subscription (Martin, 2015). SonnenCommunity members have access to Sonnen's low-priced electricity tariff. For every kilowatt-hour shared users will receive financial compensation. The level of compensation is above the level offered by local electricity providers. The use of power is also cost-effective for users in the community, as it is below the market price (Sonnen, 2016.)

Virta – Electric Vehicle Charging as a Service

Virta is a Finnish company that offers electric vehicle charging as a service. The company offers a turnkey solution for managing the charging of electric vehicles for any scale (Virta, 2017a). Virta's platforms offer the tools for running an EV charging business globally anywhere in the world. Virta addresses the entire EV charging ecosystem. Their solutions allow running charging services from single charging points to large professional EV charging networks. The user experience is offered through web, mobile and smart watch applications (Virta, 2017b)

The CBAAS (charging business as a service) includes everything needed to operate charging services: user management, automatic infrastructure management, payment systems and customer service. The solution is open interfaced and cloud-based. It enables a large variety of business models from utility-driven infrastructure management to crowdsourcing of EV charging and roaming between networks (Virta, 2017b.)

Virta's applications offer real-time information about charging stations and their availability. Users are also able to reserve charging stations in advance to avoid unnecessary trips. Users can identify themselves using Virta's applications or with key rings and RFID cards. Virta's charging points can also be used without registration (Virta, 2017c.) Figure 15 presents Virta's mobile application.

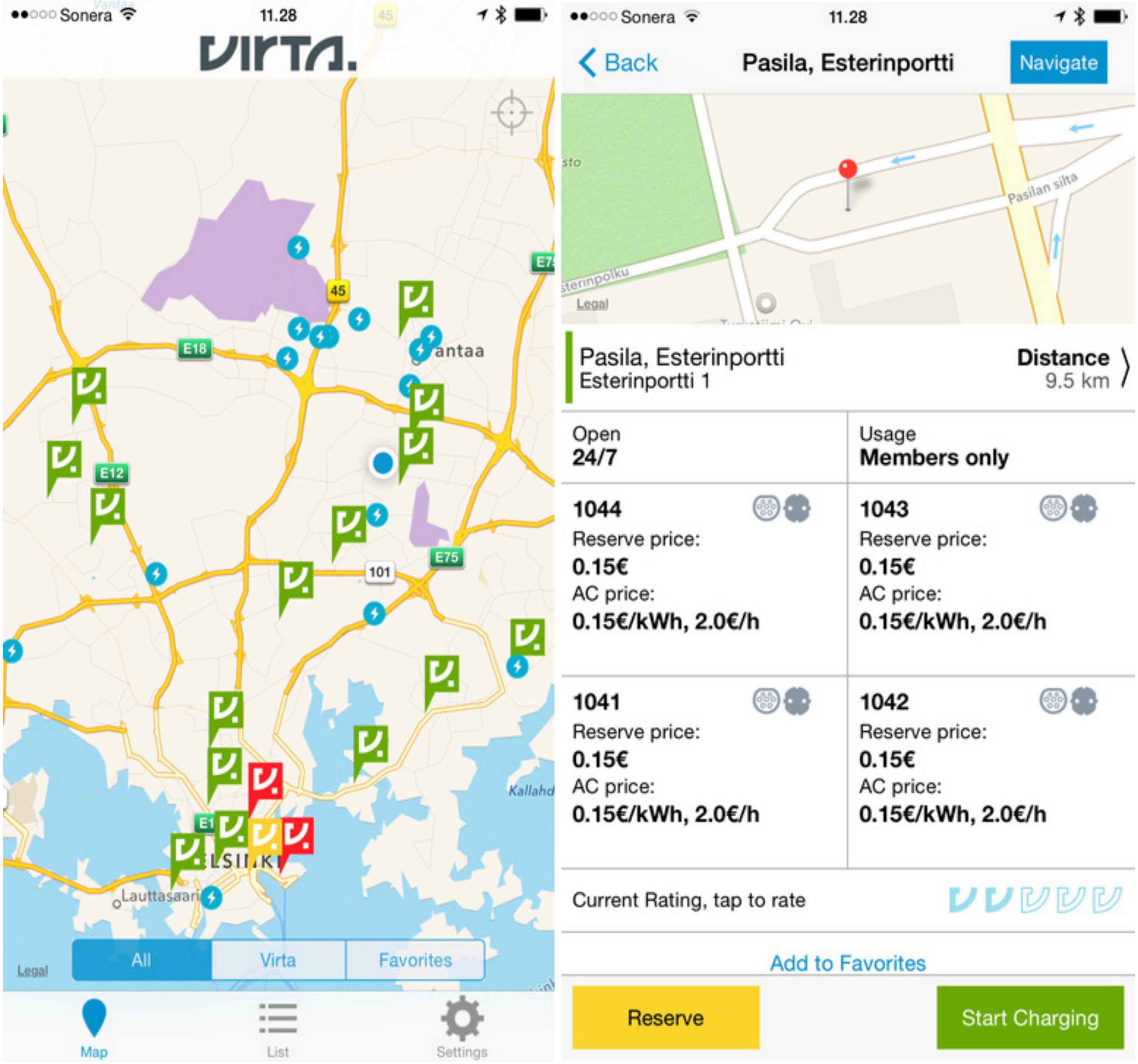


Figure 15 – Virta Application (iTunes, 2017)

Virta offers smart functionalities like grid frequency controlled charging, charging optimized based on the local energy market price and dynamic load management. Virta's solutions are also ready for vehicle-to-grid (V2G) concepts. The entire offering is also available as a white label solution. Virta's technology is used in hundreds of smart charging points in Switzerland, Germany, Iceland, Sweden and Finland (Virta, 2017b)

5.2 Platform Development

"If we want secure, clean and affordable energy, we can't continue down this path. Instead, we need to grow in a very different way, one more akin to the Silicon Valley playbook of unscaling an industry by aggregating individual users onto platforms."

- Taneja, 2014

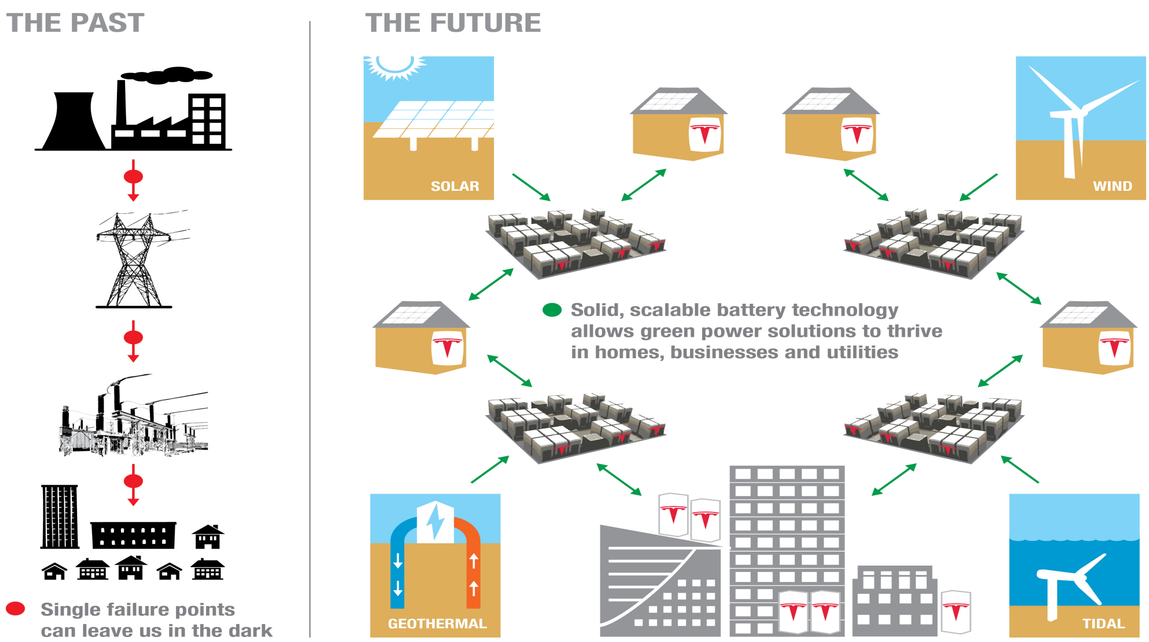


Figure 16 - Past and Future (Trough, 2015)

A variety of technology advances from electric vehicles (EVs), energy storage and renewables to peer-to-peer platforms are offering consumers new ways to receive, store and sell energy. Figure 16 examines how new technologies can affect the dominant vertical electric power industry structure. Most of these options do not require the traditional utility role. Online communities are emerging to connect local customers with renewable energy producers in their chosen area – bypassing the need for a utility. Value-added industry platforms with digitally enabled services and offerings can extend the whole industry value chain beyond its traditional boundaries (Accenture, 2015.) Although there are a host of distribution-oriented platform opportunities, Accenture (2015) sees platforms emerging in home management services, data and information services and energy aggregation.

Can the electric supply be seen as platform-mediated market? Eisenmann et al. (2006) have suggested that electricity markets are evolving into platforms for matching "consumers with specific power producers, allowing them to express their preference for cheaper coal or renewable power". Kiesling (2014) also applies Eisenmann et al.'s (2006) definition of two-sided markets. The electricity network and its transactions have the characteristics of a platform. Firms incur costs in delivering energy from generators to consumers, and these costs are a result of serving both groups. In the electricity industry digital technologies have two types of platform-related effects. The reduction in transaction costs is the first one. This was a key reason behind the economic drive towards vertical integration. Digital technologies make distributed, monitoring, sensing and measurement of energy flow possible that were costly or inconceivable before the invention of the transistor (Kiesling, 2014.)

The second is the ability to handle more diverse and heterogeneous types of agents in two-sided markets. Digital sensors and automated digital switches make the automation of interconnection rules of electric vehicles, microgrids, distributed generation and diverse users into the distribution grid possible. This can be achieved in a mutually beneficial two-sided market sense. Old electro-mechanical sensors could not do this (Kiesling, 2014.)

The increasing differentiation of consumers by elasticity and type of demand, and the complex interaction between actors on the distribution network, may to lead “platform” -mediated interactions. This has been the case in industries whose business models have been influenced by information and communication technologies (ICT) (Weiller & Pollit, 2013.) Multi-sided businesses benefit the interacting groups. This comes in the form of profiting from transactions – by capturing and increasing indirect network externalities (INEs) (Valocchi et al., 2010)

Weiller and Pollitt (2013) also suggest that the electric retail has the potential of witnessing the entry of platform providers as they acquire two distinct features. The first one is volatility. The supply side (generators and grid operators) gains added value from the service of information and energy management. These provide a systems-level benefit of balancing the supply and demand of electricity in the market. Social surplus is maximized in an optimally balanced electricity market. Consumers in turn are being exposed to time-varying market prices on the consumer side (Weiller & Pollit, 2013.) Dynamic pricing (e.g. peak, real-time and time-of-use pricing) is a way of getting domestic and commercial consumers interested in their energy consumption behaviour and encourages them to take a more active role in the market (Faruqui, 2010).

The second feature is the possibility for complementary innovation in products and services due to the introduction of ICT. The current wholesale electricity market has a limited dimension of "information" that would be required to allow intermediation and matching process to happen. Micro-scale ICT (e.g. smart appliance, EV charging and smart meters) opens business model opportunities for service providers in the retail market to position themselves as "platform" intermediaries (Weiller & Pollit, 2013.)

Traditionally the electric power industry has operated as a single-sided platform. Before wholesale generators, the business operated as the simplest kind of platform – owning the whole value chain. Some utilities even had control over fuel production. This resulted in a highly vertically integrated industry structure. With the addition of new value in the network, the industry model innovators will create businesses that resemble multi-sided platforms. In these multi-sided platforms, there may be multiple sellers and buyers – a party can also take both roles (Valocchi et al., 2010.) Figure 17 outlines the distinction between multi-sided platforms and vertically integrated structures.

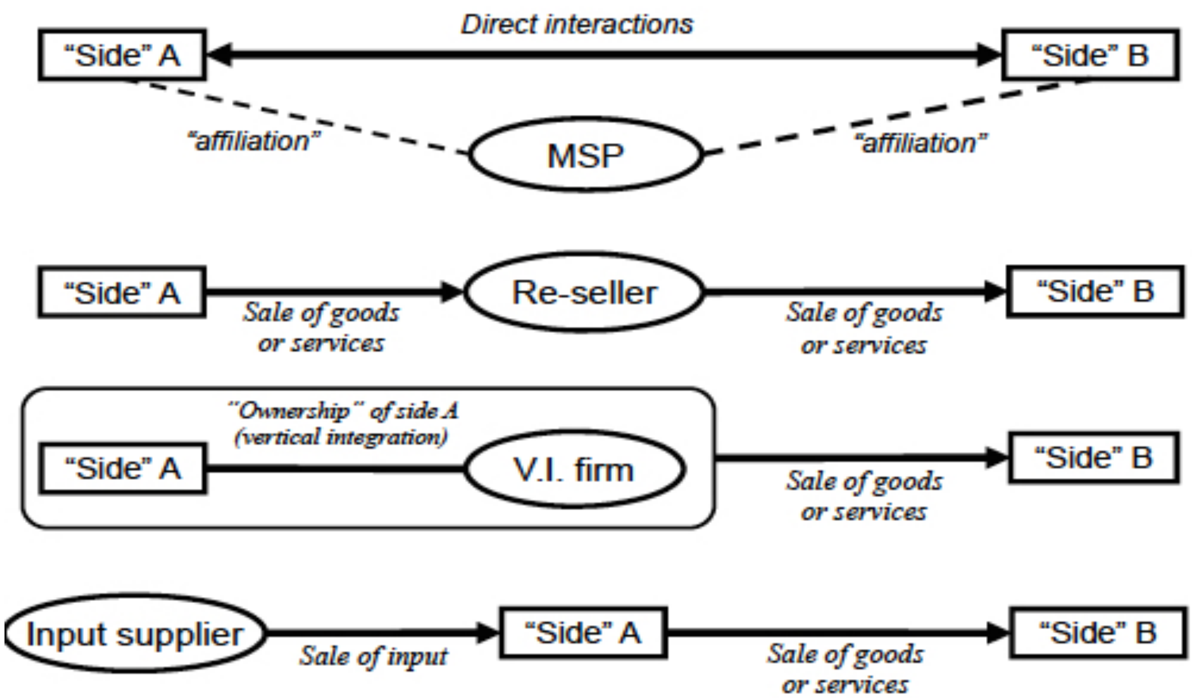


Figure 17 – MSPs vs. Alternative Business Models (Hagiu & Wright, 2015, 165)

Until now the industry has not had a lot of reason to create multi-sided platforms. This is because its product delivery has been a completely physical process. Energy and information flow have been unidirectional (Valocchi et al., 2010.) Valocchi et al. (2010) suggest that this is about to change. Emerging platforms will most likely facilitate direct transactions between distributed energy producers and energy consumers. Analogies can be drawn from the way AirBnB's platform disrupted the hospitality industry by connecting travellers and hosts. In the energy sector this could mean that neighbours buy and sell electricity directly with each other. Utilities have an opportunity to participate and choose their role in maintaining these platforms or in facilitating these peer-to-peer and local transactions (Accenture, 2015.)

Valocchi et al. (2010) state that in the coming years smart grid technologies will allow the electric power industry multi-sided platforms. Dynamic energy and information flow will support interaction amongst ecosystem participants. These platforms will link device manufacturers, service providers, application developers, energy suppliers and end-users (commercial, industrial, residential). Participants need access to a platform to reach other groups (Valocchi et al., 2010). Table 2 illustrates examples of potential multi-sided platforms in the electricity ecosystem.

Table 2 – Examples of Potential Multi-sided Platforms in Electricity (Valocchi et al., 2010, 10)

Ecosystem function	Participating sides	Platform providers
Carbon capture and storage (CCS)	Generators, carbon product users	CCS plant operators
Carbon disclosure reporting	Governments, NGOs, consumers, utilities	Third-party reporting organizations
Demand response	Consumers and businesses, distribution companies/utilities	Demand response firms
Electric vehicle charging	Consumers, power retailers, automakers	Public space providers (malls, parking garages, etc.)
Electricity comparison shopping	Consumers, power retailers, advertisers	Portal providers
Electricity transport	Power retailers, energy users, distributed generators	Transmission/distribution companies
Energy aggregator/marketer	Consumers, power retailers	Energy aggregators
Energy broker	Power retailers, energy users, distributed generators, generating companies	Energy brokers/traders
Energy management	Consumers and businesses, energy management service providers, application and content providers	Device/system makers or portal providers
Energy storage	Distributed generators, energy users	Energy storage operators
Information aggregator (device based)	Consumers and businesses, providers of energy products and services, application and content providers	Device/system makers
Information aggregator (portal based)	Consumers and businesses, providers of energy products and services, application and content providers	Portal providers
Renewable/carbon credit aggregation/trading	Renewable generation owners, coal/gas/oil generation owners, power retailers, governments	Third-party market makers

With immense investments in smart grid, today's electric companies will be responsible for building the infrastructure necessary for new industry participants to emerge. Simultaneously it is likely that new electricity related business models will emerge that will leverage smart grid infrastructure. These businesses will likely be launched by firms that did not make direct investments into the smart grid infrastructure (Valocchi et al., 2010.)

As firms embrace platforms they increase their capabilities to solve bigger problems, serve their customers better and attack bigger opportunities. Innovators know that they cannot do all this by themselves. They must make shift from their own successful efforts ("me") towards the success of all players in their platform-based ecosystems ("we"). Energy providers in the digital energy ecosystem need to build a core competence in partnering with a variety of firms (Accenture, 2015.) Besides the end-user, any party can act as a platform owner in the ecosystem. This could mean, for example, that a device manufacturer builds can be a multi-sided platform and take on the responsibility of the platform owner – including all interaction with end-user, application providers and energy retailers (Valocchi et al., 2010.)

5.3 Rise of the Prosumer

Co-creation is a key force behind changes occurring in the electric power industry. Customer preferences are having a great impact on the new technologies being introduced in the sector. No single technology can succeed purely on technological features (cf. Honkanen, 2016; Aho, 2016; Markkula, 2016; Shaughnessy, 2015). Customers need to be able to understand and adopt new technologies in order for them to have a greater impact.

This is changing the whole dynamic of the electric power industry. Until recently, end-users of electricity have been passive consumers of electricity. Prahalad & Ramaswamy (2004) state that the process of value creation and the meaning of value are shifting from a firm- and product-centric view to one that is based on personalised consumer experiences. Co-creation is thus shifting the view of the market. This will create a market between the firm and the consumer.

The prosumer (producer + consumer) is an emerging concept in the electricity market that applies to a consumer that also produces electricity. The concept has grown strong in the context of smart grids. Smart grids are more flexible and robust electrical grids. The prosumer can be a household, a plant, an office or similar. The prosumer is therefore a participant in the electricity market. Unlike the end-user the prosumer is unaffected by the state of the electricity market. The prosumer is viewed as an active player in the market, either directly or indirectly. This is the reason why a mere user-centric focus on self-sustainability is too narrow (Bremdal, 2011; Shandurkova et al., 2012.) Figure 18 examines potential shifts in the value chain of the electric power industry as a result of prosumers.

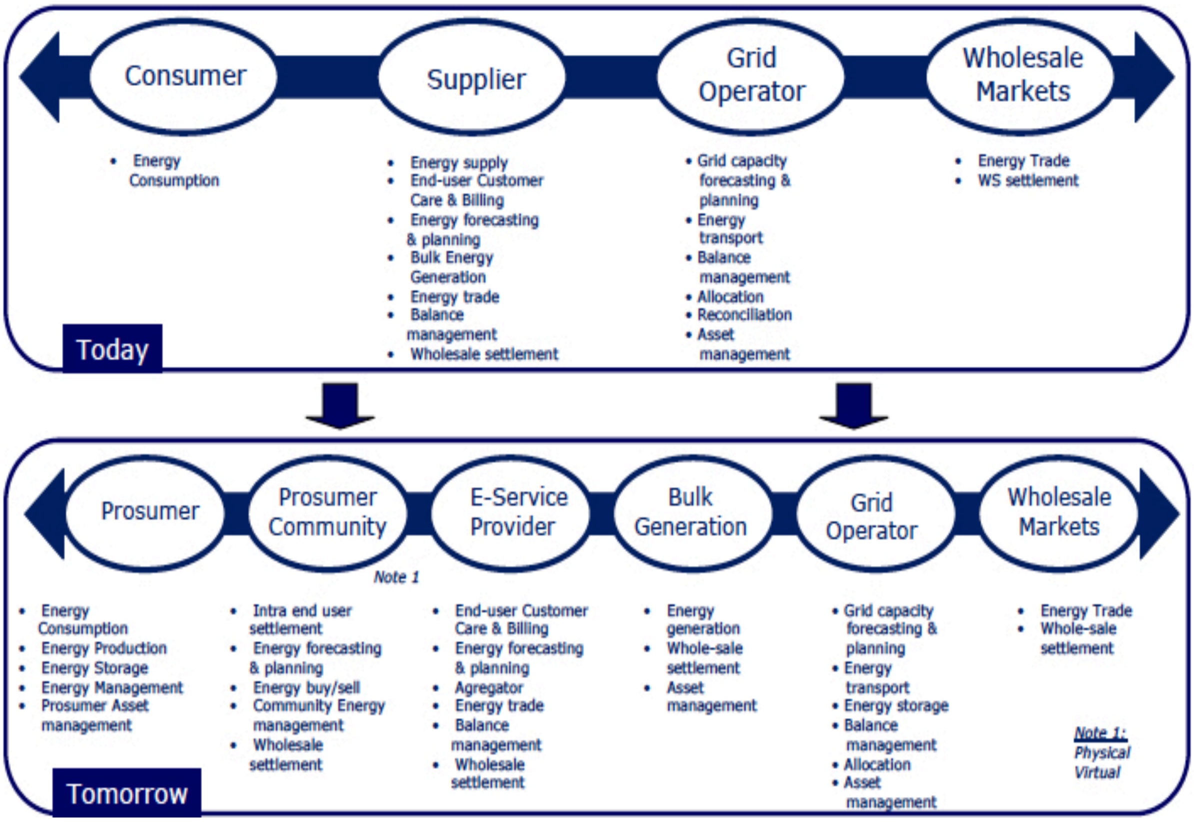


Figure 18 – The Value Chain Perspective (Hermans, 2011, 7)

Traditionally, smaller power system participants have been defined as either small consumers or small producers of electricity. However the recent technological development in distributed storage, energy resources and demand flexibility allow the small consumer to store the energy they produce. The new "prosumer" entity is an economically motivated entity that:

- consumes, produces and stores electricity and energy in general
- optimises the economic and to some extent the technological, environmental decisions regarding its energy utilization
- becomes actively involved in the value creating effort of an electricity or energy service of some kind (Shandurkova et al., 2012.)

The prosumer segment is advancing from an interesting into a multifaceted reality. More complex and interactive relationships with consumers are required as more and more consumers become power generators. This will shift the traditional one-way flow of power into bidirectional flow. All consumers have opportunities to play a dominant and pivotal role in the energy ecosystem. Personalized energy will affect the way consumers interact with utilities, and how utilities ultimately run their business (Accenture, 2015.)

The transition holds revolutionary potential. However, it is likely to evolve slowly due to two reasons: first, the high price of distributed generation compared to grid-delivered power, and secondly, most consumers lack the education and motivation to make them consumers of the new distributed energy solutions. With technological progress and higher traditional electricity prices the situation may be turned around. This makes distributed generation more productive and less expensive. The appeal to go "off-grid" grows as more and more neighbours opt for distributed generation (Carvallo & Cooper, 2011.)

Most approaches take an individualistic perspective on the prosumer. The traditional top-down perspective on the consumers may not be applicable to prosumers when they realize the market power they constitute. Prosumers can form prosumer communities that are comparable to those which formed the World Wide Web (Shandurkova et al., 2012.) This is changing the way utilities view customers. Large amounts of individual customers may be a valuable asset to the whole electricity system if control of this system can be kept centralized to some extent. Demand response and frequency balancement provide new ways for customers to participate and new market opportunities.

5.4 Potential Directions in the Business Environment

"The smart grid is the integration of an electric grid, a communications network, software, and hardware to monitor, control, and manage the creation, distribution, storage and consumption of energy. The smart grid of the future will be distributed, it will be interactive, it will be self-healing, and it will communicate with every device."

– Carvallo & Cooper (2011, 1); see cf. Carvallo (2004)

The principal driver of the modern economy has been the technological progress pushing communications and computation capability to the edges of the network supplementing or supplanting a resource previously at the centre of the distribution network. With energy production technology is making this possible in the electricity power industry as well (Carvallo & Cooper, 2011.) The question: "why it is inevitable for the grid to evolve?" is often asked. As the number of connected devices grows, the level of complexity of the grid rises. This will require new protocols in order to maintain stability. Carvallo and Cooper (2011) state that is inevitable because the geodesic Web design is superior for adaptability and flexibility in an unpredictable and highly dynamic environment. The current design of grid is neither sustainable nor suitable for evolving nature of the grid (Carvallo & Cooper, 2011).

5.4.1 Smart Grid Development

The advanced smart grid is bound for emergence due to two key reasons. First, electricity remains an essential component of modern life. Modern society requires electricity. Secondly, technological progress is about individual empowerment. Only recently technological progress in computers, networking, device power management technology and software caught up with pace of innovation in order to enable individual empowerment in the electric utility industry. Individual empowerment and networks define twenty-first century technology. The design of advanced smart grids will inevitably begin with a network orientation – one that accommodates all network applications and devices that might emerge in the future. Empowering individuals – to manage their production, consumption, and distribution of electricity – will be inevitable for advanced smart grids (Carvallo & Cooper, 2011.)

Figure 19 outlines possible outcomes in the shift to a more automated and distributed grid. The vertical axis describes the way energy is produced and the horizontal axis describes the way information flows in the system. In the traditional model electricity is centrally produced and then distributed to the end-user. In the off the grid model individual producers consume and produce their own energy. The smart grid 1.0 model describes the current situation in some developed markets. In this model automated systems are established, but energy is centrally produced. This promotes a broader use of data and analytics in the system.

	One-way flow	Two-way flow
Distributed	Off the grid	Smart grid 2.0, 3.0
Centralised	Traditional electricity grid	Smart grid 1.0

Figure 19 – Smart Grid Development

In the smart grid 2.0 and 3.0 models energy and information flow two-ways in the system. In these systems individual consumer can become producers. They also have access to a wider range of information concerning their energy usage. The categorization into smart grids 1.0, 2.0, 3.0 is based on Carvallo and Cooper's (2011) examples. It is useful to note that these boxes do not rule out one another. Instead, they can work as a combination of models. Some models also work better in some regions than others. An advanced smart grid can include self-sustaining microgrids or even off-the-grid units, but the overall architecture can be viewed as enabling a two-way flow of information and electricity. Figure 20 outlines potential shifts as result of smart grid development.

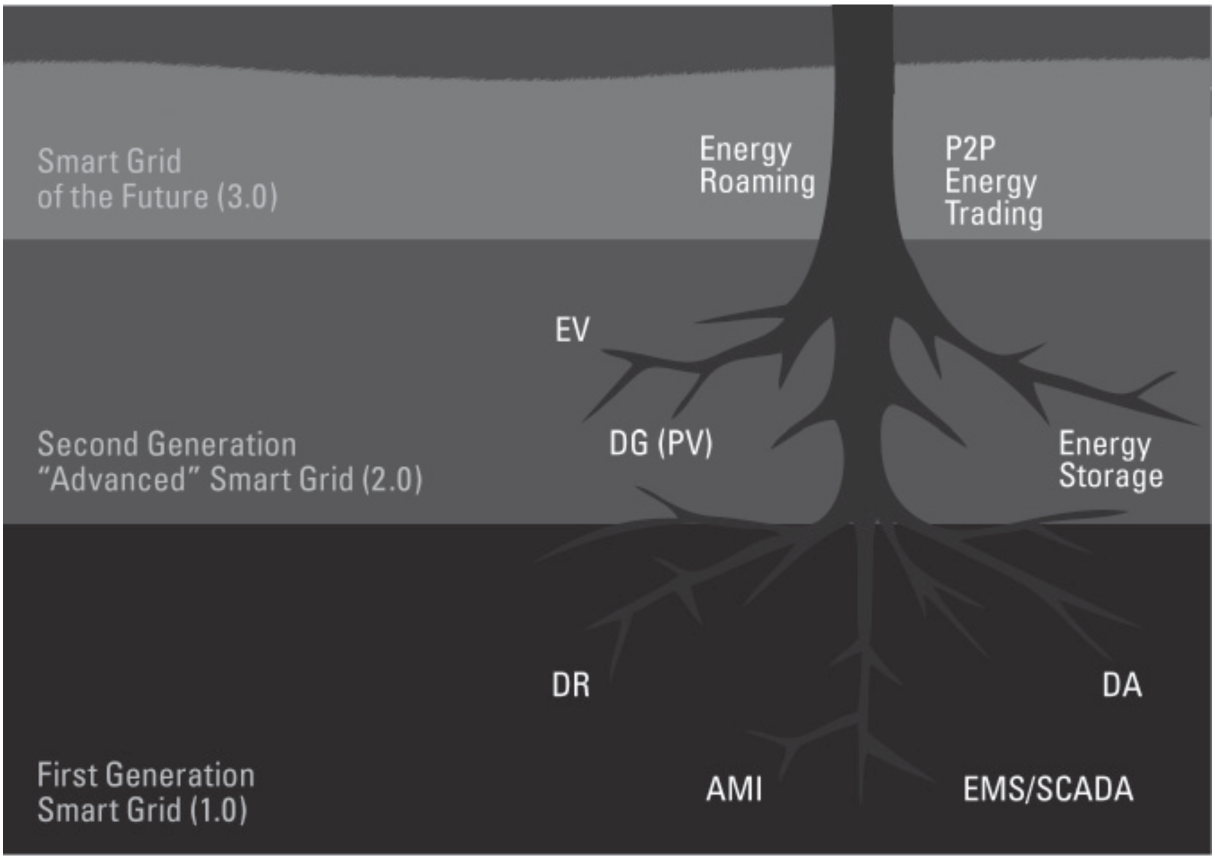


Figure 20 – Roots of the Smart Grid (Carvallo & Cooper, 2011, 8)

The smart grid also allows for further integration of small-scale energy producers (prosumers) onto the grid. According to Hermans (2011), the change towards a prosumer-based system will be associated in a number of factors and system characteristics that currently define business interactions. Table 3 outlines key changes in the business characteristics of the electric power industry. These categories are examined through the indication of a transformation to a prosumer-integrative environment.

Table 3 – Changing Business Characteristics – A Disruptive Business Transformation Ahead (Hermans, 2011, 5)

	Today		Tomorrow
Energy flow	Unidirectional	→	Bidirectional
Grid	Few to Many, hierarchical	→	Many to many, mazed
Parties	Consumers, Producers Suppliers, Markets, DSO & TSO	→	Consumers, Producers, Prosumers, Broker, Markets DSO & TSO
Role of customer	Energy Consumption	→	Consumption, Production, Storage
Portfolio E-supplier	Energy Supply, Trade Customer care & Billing	→	Risk management, Balancing, Settlement, Trade, Customer Care & Billing, Asset management, Advisory
End user Price	Fixed , fuel based	→	Volatile, weather based
Risk at	Supplier	→	Prosumer, Broker
Margin based on	Revenue- Energy costs- internal costs	→	Balancing/Risk management, Transaction based margin
Forecasting	Relevant for supplier	→	Relevant for Prosumer & Broker

These characteristics outline significant shifts in the dominant logic and structure of the industry. Bidirectional energy flows will increase as a result of new technologies and co-creation. Consumers will also become producers. The traditional value chain of the industry will have to evolve to accommodate the new technologies, prosumers and platform development that will become a part of the overall system.

5.4.2 Industry Value Development

The traditional value chain consists of "the generation-transmission-distribution-retail pathway" from energy source (primary fuel) to end-use. Consumers play a passive role, with exception of the largest customers. The recharacterisation of the value chain will transform the value proposition among energy, product and service products, in addition to the customers of these companies and the value model of the of the whole industry (Valocchi et al., 2010.)

Smart grid technologies add complexity to the network – moving information and power in different directions. At the same time this enables new participants and business models in the fields. Assets, such as energy storage, plug-in vehicles and small-scale renewable generation extend the value chain closer to the end-user. These distributed resources have an increasingly vital role in value creation as well as operation. In the long term, they may disrupt the traditional electricity pathway (Valocchi et al., 2010.) Figure 21 examines potential industry value development.

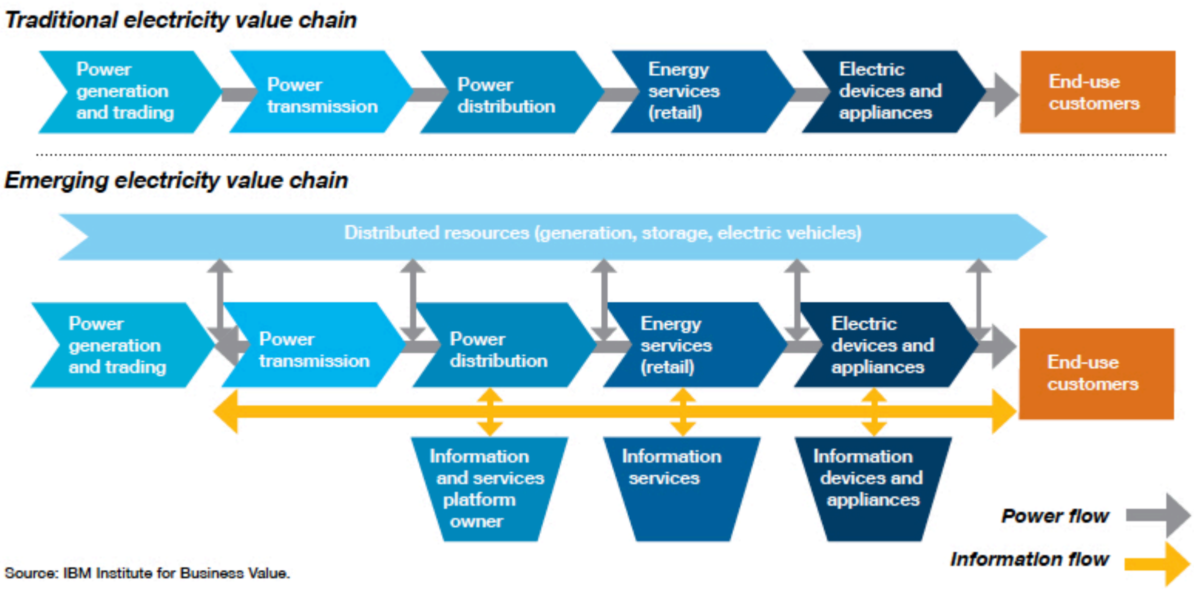


Figure 21 – Traditional and Emerging Electricity Value Chain (Valocchi et al., 2010, 4)

The value model represent a combination of value provided to customers along with the reciprocal value received by the customer as a result (cf. Wendy, Steenbakkers & Jägers, 2007). The traditional value model involves providing customers with reliable universal power with reasonable rates. The providers then receive reciprocal value in the form intermittent revenue (usually monthly). As the frequency and number of reciprocal increases the value exchanges increases, so does the complexity of the ecosystem. This results in dramatic increases of the total value available in the systems available for capture by ecosystem participants (Valocchi et al., 2010)

The volume and flow of information alone, along with the new services enabled by it are powerful contributes to the continuous flow of new value (Valocchi et al., 2010). The ability to balance and forecast loads as well as offer targeted services and products to customers on a more individualised basis will be enhanced with this data. With power flowing from multiple sources it will have to be metered and billed. Information flow will play a more significant role in shaping the value chain of the industry. This information-rich environment can create new products, services and business models (Valocchi, Schurr, Juliano & Nelson, 2007.) This can have wide implications as the industry has traditionally focused on selling units of electricity as commodity.

6 EMPIRICAL FINDINGS AND DISCUSSION

This Chapter will bridge the previous two empirical Chapters and examine them through the theoretical framework presented in Chapter 2.

6.1 Towards Horizontal Disruption

The electric power industry has been traditionally operated as a strictly vertical industry. Horizontal disruptions will therefore have large implications on the structure and dominant design of the industry. Development in technologies is pulling down the boundaries of vertical industries (cf. Shaughnessy, 2015). With the combination of co-creation and technology the vertical structure or pipeline (cf. Van Alstyne et al., 2016) of the industry has the potential of witnessing the introduction of new platform development.

Until now, the electric power industry has evolved based on the pipeline structure. Value has been directed in this simple platform to be consumed by the end-user. This was specifically the case before the deregulation of the sector, as the electricity utility resembled a monopoly. The same firm controlled the whole value chain from generation to retail. This structure was split further as deregulation began. Generation and distribution of electricity were separated. Further on, this structure evolved to accommodate individual retailers that did not own any generation or distribution assets (Markkula, 2016.) This is the current situation in the industry.

6.1.1 Horizontal Expansion

The pipeline model of the electric power industry is currently being challenged by new technologies. Cost-effective renewables, energy storage and distributed energy resources are altering the way energy can be produced, stored and distributed. This is enabling a significant shift in the role of the individual consumer. Previously the role of the consumer has been to consume the electricity and value produced by the utility. This may no longer be the case as consumers are provided with new technologies that have an impact on this strictly vertical structure. Scaling power plants further is no longer viable (cf. Markkula, 2016).

The consumer and producer roles are colliding and being intertwined (Aho, 2016; Honkanen, 2016). This is resulting in new forms of prosumerism (cf. Toffler, 1980) in the electric power industry. New technologies offer the tools for consumers to become producers. Traditional economies of scale and high barriers to entry do not apply to cost-effective distributed energy resources. As Shaughnessy (2015) states there are no categories or barriers other than those we imagine. Together these forces are opening up the vertical structure for horizontal development (cf. Shaughnessy, 2015.) Co-creation is a strong force, but it still requires a structure in order to be utilised in the marketplace. This is where the potential new platforms emerges and drives horizontal expansion.

A similar shift of horizontal expansion has occurred in the telecommunications sector. These analogies may provide insight into the development of the electric power industry. The ecosystem in this previously mentioned industry has expanded to accommodate a variety of software-based services and platforms. Whereas the focus in telecommunications has previously been on the network and corded phones, it has shifted towards the edge, with customers and their mobiles phones and software services. This can hold clues to the development in the electric power industry as new technologies disrupt the dominant vertical barriers of the industry. New services are already springing up on the end-user side of the dominant value chain and/or between utilities and the end-user (Aho, 2016; Honkanen, 2016; Kananen, 2017; Markkula, 2016.)

Traditionally the electric power industry has operated with a strong focus on hardware and operating in the physical world (Aho, 2016). In comparison, the telecommunications sector has developed from central switches towards everyone owning their own mobile phone. Focus has actually shifted away from the mobile phone itself and towards software platforms like Facebook and Uber. As economies of scale in production are plateauing and distributed energy resources are getting more cost-effective this can lead to a similar development taking place in the power industry.

The industry may see a shift towards a broader focus on software development with the advent of connectedness and small-scale production. The industry is becoming increasingly software-driven. Previously there has been no need to develop the system to accommodate further software development. With increasing pressure from consumers and new technologies this is changing. Software is needed to accommodate the variety of growing amount of transactions.

Co-creation and new technologies are also increasing demand side control. Demand response can shift the single-sided focus on production towards demand (cf. Aho 2016; Auvinen, 2016; Kananen, 2017; Markkula, 2016). Instead of scaling the old power plants further, it is possible to begin to match demand with production in completely new ways and at a point closer to the end-user. With smart technologies it is also possible to begin controlling demand (Kananen, 2017). This is a completely new thought since the focus has always been on balancing demand through production and not addressing demand itself.

It is clear that new business models and structures are set to develop in the electric power industry. Co-creation and smart grid technologies require a way of structure that can facilitate exchange between individual consumers and producers. Smart grid technologies are allowing the two-sided exchange of electricity and information. This is creating the opportunity for platforms to emerge in the sector and for more value to be exchanged in the ecosystem. Figure 22 illustrates how co-creation and new technologies initiate strong horizontal forces that open up vertical industries for horizontal development.

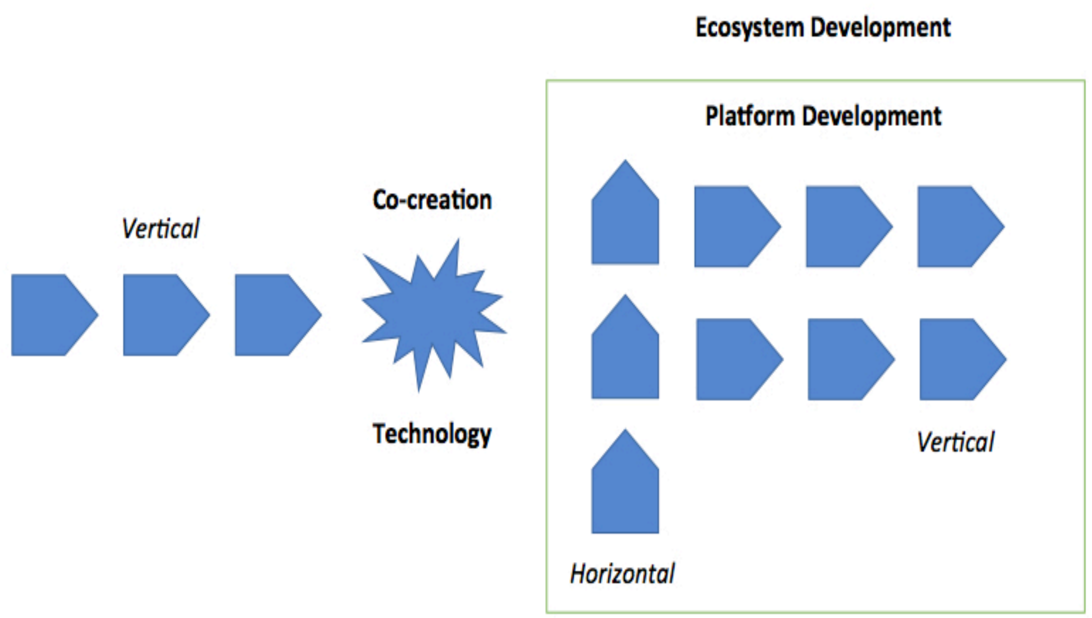


Figure 22 – Horizontal Expansion

Currently, we are seeing players like Sonnen, Vandebron and Virta offer their respective platforms. Tesla is also poised to have a significant effect with their combination of EVs, energy storage and solar roofs/panels. These platforms represent new ways of creating and capturing value compared to the vertically integrated model of the industry in the past. The electric power industry is poised to expand horizontally as industry lines will continue to blur.

6.1.2 Ecosystem Development

"As the era of Smart Grid 3.0 dawns, the advanced smart grid will become not just a way to deliver electricity more efficiently, which will bring tremendous value; it will become an entirely new social and transactional platform." - Carvallo & Cooper (2011, 215)

Multi-sided platforms can facilitate exchange with individual consumers and producers, but also with other network participants. Information and data will flow bidirectionally (Aho, 2016; Honkanen, 2016). This creates evermore value in the system. Multi-sided platforms can leverage this value in many ways and not all of them will be entirely consumer-focused, but instead work with utilities and provide them relevant information and electricity flows.

The complexity will increase as the amount of data and electricity being exchanged in the system increases. Smart grids will handle value on two fronts: megabits and megawatts. This will result in a broad horizontal electric power ecosystem, where new technologies, platforms and co-creators create and exchange value in new ways. The advanced smart grid (cf. Carvallo & Cooper, 2011) is emerging to handle all of this complexity. A smart grid is set to evolve to match bidirectional flows of electricity and information and match a broad set of production assets with demand.

Traditional utilities will have to recognise these changes and proceed accordingly. The dominant business logic of selling units of a commodity is no longer viable. Instead utilities will have to shift their attention towards relationships (cf. Normann & Ramírez, 1993; Shaughnessy, 2015). These utilities will have to decide to on a strategy of expanding horizontally or being a link between the individual parts of the developing value network. This may entail a shift from resource control to resource orchestration (cf. Peppard & Rylander, 2006; Van Alstyne et al., 2016.) Value may no longer be tied to the ownership of the underlying assets.

New participants will enter the emerging ecosystem from a variety of backgrounds. Software and technology (Auvinen, 2016; Honkanen, 2016; Markkula, 2016) companies are obvious new entrants. This will create a sense of fragmentation. Incumbents will not always be able to address needs that arise in this fragmenting marketplace. Smaller companies are better positioned to test new approaches and business models. New platforms are set to emerge around the end-user (Aho, 2016) and/or between the end-user and existing participants (Auvinen, 2016; Markkula, 2016). These platforms can leverage distributed energy resources and data to create value.

The transformation of the industry will create a broad horizontal electric power ecosystem. New technologies, companies and prosumers will rise to prominence in this ecosystem. The dominant vertical electric power industry did not have any reason to develop such a broad ecosystem. Horizontal forces are the key drivers behind this horizontal ecosystem expansion. This will create a lot of complexity in the system. This is where platforms can dominate. Van Alstyne et al. (2016) state that when a platform enters a pipeline organisation's market the platform almost always wins. Ultimately, platforms are well-suited to adapt to these changing conditions and handle a fragmented market place.

6.2 Discussion

This study gives confirmation for Shaughnessy's (2015) statement of the economy becoming horizontal in the context of the electric power industry. However, not all industries are horizontal – yet. This may change as an increasing amount of interconnected technologies and co-creation begin to impact other vertical industries.

The electric power industry is in the midst of a transition (Aho, 2016; Auvinen, 2016; Honkanen, 2016; Markkula, 2016). The grid needs to be disrupted (Kananen, 2017). There will be a need for electricity in the future, but market models and production will change in the future (cf. Honkanen, 2016). The emerging smart grid is creating a completely new model of exchanging electricity and information. The grid is shifting from an analogue pipeline towards a digital industry platform much like the Internet.

The lines of traditional industry thinking are blurring as new technologies combine elements from information technology, transportation, security, and housing among others. What technology platform giants like Google and Apple may exemplify is the fact that this type of "industry-based" -thinking may be a thought from the past. New technologies will cause turmoil while new companies and 'industries' are born based on new platforms and new ecosystems. The speed of change is also increasing rapidly. This will create an ever-increasing amount of winners and losers. In the past, sustaining innovations drove development for years in the electric power industry.

Platforms seem to be more adaptable to change than vertically integrated pipelines. Multi-sided platforms demonstrate the capability of matching individual value creation activities of individual prosumers. However, there is still uncertainty in literature what a platform is. Is it a business model or is a structure or both? More research is needed on the topic. The concept of industry platform is also an interesting one. The platform model is currently challenging the dominant focus of industries as the unit of analysis in business literature, but still literature focuses on the concept of industry.

In the beginning these platforms may create fragmentation in the marketplace, but ultimately it is likely for some platforms to develop platform ownership in distinct areas. These horizontal actors may therefore begin with horizontal expansion, but may end up integrating vertically. Horizontal actors will expand the value network and integrate on whole new levels in the value network that did not exist previously. Value is shifting towards adjacent parts in the ecosystem. This puts the traditional strategies of vertical and horizontal integration under question in the future. Can such a strict strategy be adaptable enough to cope with the changes in the future?

These platforms can become increasingly powerful as they ultimately expand horizontally to handle both information and electricity flows in the broad ecosystem under development. Platforms can create value on completely new levels and are not stuck in the dominant value chain model of the electric power industry. Ultimately, they can scale to develop utility power. Shaughnessy (2015) refers to platforms as modern utilities. These platforms create utility power based on their enabling role (Shaughnessy, 2015.) This is what is happening in the context electricity – platforms are enabling co-creation based on new technologies.

Kenney and Zysmann (2016) state that a digital platform economy is emerging. Companies including Facebook, Google, and Uber are creating online structures that enable a host of human activities. This results in powerful organisations that control and enable transactions. The economy is polarizing around highly distributed ecosystems and platforms, groups that create new forms of community around service delivery and production (Shaughnessy, 2015). This shift is already impacting the electric power industry with the advent of digital connectedness and the development of smart grids. Selling electricity as a commodity may become an out-dated model as value is shifting to new levels in the ecosystem. Controlling data flows can create a host of new value models. Ultimately, data may become the new commodity of the emerging horizontal electricity ecosystem.

6.3 Contributions of the Study

6.3.1 Academic Contributions

There is an increasing amount of academic literature being written about platforms. This research has produced the concepts of multi-sided platforms and industry platforms. These terms are have become established, but there is still a lot of overlapping use and misuse of these terms. It is still unclear if these concepts can be viewed as describing structures of industries, business models or both. This study provides new insight into how platforms change value development compared to value development under the vertically integrated structure.

The development of vertical industries to horizontal ones has been given increasing amount attention since the birth of strong platform organisations in the 2010s. The major contribution of this study is the development of a framework for the development from a simple vertical structure of an industry towards a broad horizontal ecosystem. This creates complexity of structuring industries as new players are able to co-create value. Platforms offer ways to address this complexity, but simultaneously question the focus of industry as a dominant unit of analysis in business literature.

6.3.2 Managerial Contributions

This study provides insight into the impacts of horizontal forces on vertical industries. The platform model is viewed as the answer to this shift. This poses strong implications for managers as platforms differ from the ways businesses have traditionally been structured in these industries. The focus on core competency may not be sufficient as new platforms emerge and begin to disrupt individual parts of the dominant vertical electricity value chain. The undergoing transformation in the electric power industry requires managers to make key strategic decisions on their companies' future and how they are accustomed to handling complexity and the use of new technologies.

This study illustrates examples of platforms that are emerging the new broad horizontal electric power ecosystem. These platforms create value and can scale more efficiently. Instead of a strong focus on control, they are enabling individuals to co-create value. This is why traditional concepts of high barriers to entry and a focus on ownership of resources are no longer applicable.

6.4 Future Research

The research provides insight into forces of technology-driven horizontal pressures on the dominant vertical electric power industry. This is a very broad topic and there is limited previous research on this topic. Previous research has typically focused on the impact of individual technologies and their effects on the industry. This study however aims to provide a holistic understanding of the horizontal disruption occurring in the industry. There is a need for further studies on the topic to describe the emerging horizontal electric power ecosystem. Analysing the effects that political and legislative forces can have on this development is crucial in understanding the future development of the industry.

Horizontal forces impact vertical industries at increasing rates. This will require new structures to be developed to address these forces. This study holds clues to how these forces can disrupt these dominant ways of structuring industries. It would be interesting to study how horizontal forces impact other vertical industries and if the same conclusions could be drawn from these studies. Other industries to analyse could include: discrete manufacturing, the traditional retail industry and the financial sector.

The shift from a production-based system towards controlling demand is another interesting dynamic found in this study. Platforms are forming to address this dynamic and shift value in multiple directions. Distributed resources can be utilised more efficiently to match demand and production. More research is needed on the topic of controlling the demand of electricity and its effects on the power system. Business models for demand response will need to be developed for there to be enough incentives for the end-user to participate.

Distributed energy resources also provide another interesting opportunity for disruption in the electric power industry. Ultimately, it is possible go off-grid with a combination of small-scale generation and energy storage. This can be an attractive option in developing markets where the grid is unstable or has not yet been established. Ultimately, it can be possible to leapfrog the grid in some locations. It would be interesting to study distributed energy resources in the context of developing markets and rural areas.

LIST OF REFERENCES

Abernathy, W. J. & Utterback J. M . (1978). Patterns of innovation in technology. *Technology Review*, 80: 40–47.

Accenture, (2014). *The New Energy Consumer – Architecting for the Future*.

Accenture, (2015). *The New Energy Consumer – Unleashing Business Value in a Digital World.*

Armstrong, M. (2006), Competition in two-sided markets. *RAND Journal of Economics*, 37, 668–91.

Bendapudi, N. & Leone, R.P. (2003). Psychological implications of customer participation in co-production. *Journal of Marketing* 67(1), 14–28.

Bergius, I. (2012). *Matkapuhelintoimialan murros*. Master's thesis. University of Tampere.

Bergman, J-P., Dukeov, I., Ahola, J. & Ahonen, T. (2016). *What are the rate, direction and impacts of the technological transition? : Review of megatrends in Energy Sector*. Smart Energy Transition Project. Published 4.11.2016.

Bloomberg (2016). *World Energy Scenarios*. Full Report, World Energy Council in collaboration with Accenture Strategy and Paul Scherrer Insititute.

Bremdal, B. A. (2011). Prosumer Oriented Business in the Energy Market. IMPROSUME Publication Series #2.

Bruno, C. (2011). *Economies of vertical and horizontal integration, unbundling and quality of service in public utilities: a literature review*. Working paper n. 5/2011. University of Bergamo and HERMES.

Carvallo, A. & Cooper, J. (2011). *The Advanced Smart Grid: Edge Power Driving Sustainability.* Artech House, Norwood MA.

Christensen, C. (1997). *The Innovator's Dilemma*. Harvard Business School Press, Boston.

Christensen, C. (2014). *The Capitalist's Dilemma*. Harvard Business Review. June 2014. 2-9.

Chesborough, H.W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.

Cohen, W. M. & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation, *Administrative Science Quarterly*, March 1990, 128-152.

De Wit, B. & Meyer, R. (2004). *Strategy: Process, Content, Context*. Cengage Learning.

Deloitte, (2015a). *The future of the global power sector: Preparing for emerging opportunities and threats*. Deloitte Global Services Limited.

Deloitte, (2015b). *Journey to grid parity - Three converging forces provide a tailwind for US renewable power*. Deloitte Center for Energy Solutions.

Deloitte, (2016). *2016 Deloitte Energy Conference - Retrospective report.* Deloitte Center for Energy Solutions.

Deutsche Bank, (2015). *Crossing the Chasm*. Solar Report, Deutsche Bank Market Research.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. *Journal of Business Research*, 55(7), 553-560.

Downes, L., & Nunes, P. (2013). Big Bang Disruption. *Harvard Business Review*, 44-56.

Eisenmann, T., G. Parker and M. Van Alstyne (2006). Strategies for two-sided markets. *Harvard Business Review*, 84 (10), 92–101.

Eriksson, P., & Koistinen, K. (2005). *Monenlainen tapaustutkimus*. Helsinki, Finland: Kuluttajatutkimuskeskus.

Eriksson, P. & Kovalainen, A. (2008). *Qualitative methods in business research*. London: Sage Publications.

Erlinghagen, S. & Markard, J. (2012). Smart grids and the transformation of the electricity sector: ICT firms as potential catalysts for sectorial change. *Energy Policy*, Volume 51, December 2012, 895-906.

Evans, D.S. (2003a). The antitrust economics of multi-sided platform markets.*Yale Journal on Regulation,* 20, 325–82.

Evans, D.S. (2003b). Some empirical aspects of multi-sided platform industries. *Review of Network Economics*, 2(3), 191-209.

Evans, D.S. (2009). *How catalysts ignite: the economics of platform-based start-ups*. Cheltenham, UK and Northampton, MA, US: Edward Elgar.

Faruqui, A. (2010). The Ethics of Dynamic Pricing. *The Electricity Journal*, 23(6), pp.13–27.

Gawer, A. (2009). *Platforms, Markets and Innovation*. Edward Elgar Publishing Limited, Cheltenham: UK.

Gawer, A. (2014a). Bridging differing perspective on technological platforms: Towards an integrative framework. *Research Policy*, 43, 1239-1249.

Gawer, A. & Cusumano, M.A. (2002). *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*. Boston, MA: Harvard Business School Press.

Gawer, A., & Cusumano, M. A. (2008). How companies become platform leaders. *MIT Sloan Management Review*, 49(2), 28.

Gawer, A., & Cusumano, M. A. (2014*). Industry platforms and ecosystem innovation*. Journal of Product Innovation Management, 31(3), 417-433.

Ghauri, P. and Grønhaug, K. (2010). *Research Methods in Business Studies* (4th ed.). Harlow: Pearson.

Gluski, A., Shelton, C. (2016). *After a 100-Year Hiatues, Batteries Are Helping the Grid Again*. Key Trends Driving Change in the Electric Power Industry, Volume II. The Edison Foundation Institute for Electric Innovation.

Gossain, S. & Kandiah, G. (1998). Reinventing Value: The New Business Ecosystem. *Strategy & Leadership*, Vol. 26(5), pp. 28-33.

Gottfredson, M., Norton, J., Crichlow, J. & Sinha, A. (2013). *How utilities should evaluate upstream and downstream integration.* Bain & Company, Inc.

Hagiu, A. & Wright, J. (2015). Multi-sided platform. *International Journal of Industrial Organisation*, 43, 162-174.

Hirsjärvi, Sirkka and Hurme, Helena (2011). *Tutkimushaastattelu. Teemahaastattelun teoria ja käytäntö*. Gaudeamus Helsinki University Press.

Hirsjärvi, S., Remes, P. & Sajavaara, P. (2009). *Tutki ja kirjoita*. Helsinki: Kustannusosakeyhtiö Tammi

Iansiti, M. & Levien, R. (2004). *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Harvard Business School Press, 225p.

Johnson, G., Scholes, K. & Whittington, R. (2008). *Exploring Corporate Strategy. 8th Edition*. Person Education Limited, England.

Kenney, M., & Zysman, J. (2016). The Rise of the Platform Economy. *Issues in Science and Technology,* 32(3), 61-69.

Keynes, J. M. (1936). *The General Theory of Employment, Interest and Money*.

Kondratieff, N. (1925). *The Major Economic Cycles*.

Koskinen, I., Alasuutari, P., & Peltonen, T. (2005). *Laadulliset menetelmät kauppatieteissä*. Tampere: Vastapaino.

Kyngäs, H. & Vanhanen, L. (1999). Sisällönanalyysi. *Hoitotiede 1999*: 11(1), 3-12.

Klepper, S. & Simons, K. L. (1997). Technological Extinctions of Industrial Firms: An Inquiry into Their Nature and Causes. *Industrial and Corporate Change* 6, No. 2 (June 1997): 379–460.

Kotler, P. (1986). The prosumer movement: A new challenge for marketers. *Advances in Consumer Research*, 13, 510–513.

Lazard (2015). *Lazard's Levelized Cost of Energy Analysis* -Version 9.0.

Lewin, R. & Regine, B. (1999). *On the Edge in the World of Business.* In Lewin, R. Complexity: Life at the Edge of Chaos. The University of Chicago Press, pp. 197-211.

Mason, J. (2002). *Qualitative Researching London*: Sage Publications Ltd.

Meyer, M.H. & Lehnerd, A.P. (1997). *The Power of Product Platforms: Building Valueand Cost Leadership*. Free Press, New York.

Miettinen, V. (2017). *Arvonluonti alustataloudessa*. Master's Thesis, University of Tampere.

Rodríguez-Molina, J., Martínez-Nuñez, M., Martínez, J-F & Pérez-Aguiar, W. (2014). *Business Models in the Smart Grid: Challenges, Opportunities and Proposals for Prosumer Profitability*. Energies 2014, 6142-6171.

Moore, J.F. (1996). *The Death of Competition: Leadership & Strategy in the Age of Business Ecosystems*. New York, Harper Business.

Moore, J.F. (1998). The Rise of a New Corporate Form. *Washington Quarterly*, Vol. 21(1), pp. 167-181.

Moore. J.F. (2006). *Business ecosystems and the view from the firm.* Antitrust Bull.

Normann, R. & Ramírez, R. (1993). From Value Chain to Value Constellation: Designing Interactive Strategy. *Harvard Business Review*, July-August 1993, 65-77.

Peppard, J. & Rylander, A. (2006). From Value Chain to Value Network: Insights for Mobile Operators. *European Management Journal*, Vol. 24 (2-3), April-June 2006, 128-141.

Porter, M. E. (1980). *Competitive Advantage: Creating and Sustaining Superior Performance*. Free Press, New York, 1980.

Porter, M. E. (1985). *Competitive Advantage*. Free Press, New York, 1985.

Prahalad, C. K. & Ramaswamy, V. (2004). Co-creation Experiences: The Next Practice In Value Creation. *Journal of Interactive Marketing*, 18 (3), 5-14.

PwC, (2016a). *A different energy future: Where energy transformation is leading us*. 14th PwC Global Power & Utilities Survey.

PwC, (2016b). *Capturing value from disruption: Technology and innovation in an era of energy transformation*. PwC Global Power and Utilities, Strategy&.

Ramírez, R. (1999). Value Co-Production: Intellectual Origins and Implications for Practice and Research. *Strategic Management Journal*, Vol. 20 (1), pp. 49-65.

Rocky Mountain Institute, (2013). *The Economics of Grid Defection: When and Where Distributed Solar Generation Plus Storage Competes with Traditional Utility Service.*

Rochet, J.-C. & Tirole, J. (2003). Platform competition in two-sided markets. *Journal of the European Economic Association*, 1 (4), 990–1029.

Richter, M. (2013). Business model innovation for sustainable energy: German utilities and renewable energy. *Energy Policy*, Volume 62, November, 1226-1237.

Ritzer, G. & Jurgenson, N. (2008). *Production, Consumption...Prosumption?* Paper Presented at the annual meeting of the American Sociological Association, Boston, MA.

Ritzer, G. & Jurgenson, N. (2010). Production, Consumption, Prosumption: The nature of capitalism in the age of the digital 'prosumer'. *Journal of Consumer Culture*, Vol. 10 (1), 13-36.

Saunders, M., Lewis, P. & Thornhill, A., (2009). *Research methods for business students* (5th ed.). Harlow: Prentice Hall.

Schumpeter, J. (1942). *Capitalism, Socialism and Democracy*. Harper & Brothers.

Shandurkova, I., Bremdal, B. A., Bacher, R., Ottesen, S. & Nilsen, A. (2012). *A Prosumer Oriented Energy Market: Developments and future outlooks for Smart Grid*.

Shaughnessy, H. (2015). *Shift: A User's Guide to the New Economy*. Disruption House, London.

Shuen, A. (2008). *Web 2.0: A Strategy Guide*. O'Reilly, 2008.

Simpson, T.W., Siddique, Z. & Jiao, J., (2005). *Platform-based product family development: introduction and overview*. In: Simpson, T.W., Siddique, Z., Jiao, J.(Eds.), Product Platforms and Product Family Design: Methods and Applications. Springer, New York, pp. 1–16.

Sood, A. & Tellis, G. J. (2011). Demystifying Disruption: A New Model for Understanding and Predicting Disruptive Technologies. *Marketing Science*, Vol. 30(2), 339-354.

Stake, R. E. (1995). *The art of Case Study Research*. United States of America: SAGE Publications, Inc.

Sviokla, J. & Paoni, A. (2005). Every Product's a Platform. *Harvard Business Review*, 83 (October 2005), 17-18.

Tapscott, D. (1997) *The Digital Economy: Promise and Peril In The Age of Networked Intelligence*. McGraw-Hill, 1997.

Tapscott, D. & Williams, A.D. (2006). *WIKINOMICS: How Mass Collaboration Changes Everything.* Portfolio, Penguin Group, New York.

Technavio, (2015). *Global Battery Electric Vehicles Market 2015-2019*. Technavio, 4 February 2015.

Thiel, P. (2014). *Zero to One: Notes on Startups, or How to Build the Future*. Crown Business: New York.

Toffler, A. (1980). *The Third Wave*. Bantam Books, New York, NY.

Tuomi, J. & Sarajärvi, A. (2009). *Laadullinen tutkimus ja sisällönanalyysi* (5. uud. pain.). Helsinki: Tammi.

Valocchi, M. Schurr, A., Juliano, J. & Nelson, E. (2007). *Plugging in the consumer – Innovating utility business models for the future.* IBM Global Services, Somers, NY.

Valocchi, M., Juliano, J. & Schurr, A. (2010). *Switching perspectives – Creating new business models for a changing world of energy.* IBM Global Business Services Executive Report, Somers, NY.

von Hippel, E. (2005). *Democratizing innovation*. Cambridge, MA: MIT Press.

Van Alstyne, M. W., Parker, G. G. & Choudary, S. P. (2016). Pipelines, Platforms, and the New Rules of Strategy. *Harvard Business Review*, 94(4), 54-60, 62.

Peltoniemi, M. & Vuori, E. (2004). *Business ecosystem as the new approach to complex adaptive business environments.* Tampere University of Technology, Finland.

Walsh, P. (2005). Dealing with the Uncertainties of Environmental Change by Adding Scenario Planning to the Strategy Reformulation Equation. *Management Decision*, 43(1): 113-122.

Walsh, P. & Todeva, E. (2005). *Vertical and Horizontal Integration in the Utilities Sector: The Case of RWE*. University of Surrey, Guildford.

Weiller, C. M. & Pollit, M. G. (2013). *Platform markets and energy services.* Cambridge Working Paper in Economics, University of Cambridge.

Wendy, J., Steenbakkers, W. & Jägers, H. (2007). *New Business Models for the Knowledge Economy*. Gower Publishing Ltd.

Yin, R. K. (2003) *Case study research – Design and Methods.* 3rd edition California: Sage Publications, Inc.

Yin, R. K. (2009). *Case Study Research*. Design and Methods (4th ed.). Sage Publications, Inc.

INTERNET REFERENCES

Battisti, G. & Giulietti, M. (2015). Tesla Is Betting on Solar, Not Just Batteries. *Harvard Business Review*. Available: https://hbr.org/2015/07/tesla-is-betting-on-solar-not-just-batteries Sourced: 20.5.2016

Changemakers (2016): Vandebron Pricing. Sourced: https://www.changemakers.com/sites/default/files/competition_entry/graph.jpg

Colthorpe, A. (2015). *Secrets of the trade: Insights into Sonnen's PV-plus-storage energy trading platform.* Available: http://www.energy-storage.news/interviews/secrets-of-the-trade-insights-into-sonnens-pv-plus-storage-energy-trading-p Sourced: 12.3.2016

Dehamna, A. (2015). *Powerwall Takes Tesla Into the Energy Cloud*. Navigant Reserach. Available: https://www.navigantresearch.com/blog/powerwall-takes-tesla-into-the-energy-cloud Sourced: 13.4.2016

Economist, The. (2014). *Platforms: Something to stand on*. Special Report. Available: http://www.economist.com/news/special-report/21593583-proliferating-digital-platforms-will-be-heart-tomorrows-economy-and-even Sourced 9.10.2015

Energy Information Administration, (2017): *Electric Power Sector*. Sourced: https://www.eia.gov/tools/glossary/index.php?id=E

Evans, P. C., & Gawer, A. (2016). *The rise of the platform enterprise: a global survey*. Sourced: http://thecge.net/wp-content/uploads/2016/01/PDF-WEB-Platform-Survey_01_12.pdf

Hermans, P. (2011). *Energy & Telco synergies*. Brussels Workshop 27 may 2011. Sourced: http://ec.europa.eu/information_society/activities/sustainable_growth/docs/events/past_events/ws_grids_utilities/stedin.pdf

Itunes, (2017). *Virta application*. Available: https://itunes.apple.com/us/app/virta/id961973824?mt=8 Sourced 29.3.2017

Kiesling, L. (2014): *Platform economics and "unscaling" the electricity industry*. Available: https://knowledgeproblem.com/2014/10/16/platform-economics-and-unscaling-the-electricity-industry/ Sourced 1.2.2016

Law, J. (2016a): *Industry*. A Dictionary of Business and Management: Oxford University. 6th Edition. Sourced: http://www.oxfordreference.com.helios.uta.fi/view/10.1093/acref/9780199684984.001.0001/acref-9780199684984-e-3251?rskey=tC4bnG&result=3376

Law, J. (2016b): *Integration*. A Dictionary of Business and Management: Oxford University. 6th Edition. Sourced: http://www.oxfordreference.com.helios.uta.fi/view/10.1093/acref/9780199684984.001.0001/acref-9780199684984-e-3331.

Martin, R. (2015): *Renewable Energy Trading Launched in Germany*. Technology Review, Available: https://www.technologyreview.com/s/544471/renewable-energy-trading-launched-in-germany/ Sourced: 20.10.2016

Meyers, G. (2015). *Germany's Sonnenbatterie Launches Energy Trading Platform*. Available: http://cleantechnica.com/2015/12/06/germanys-sonnenbatterie-launches-energy-trading-platform Sourced: 20.10.2016

Sampere, J. P. V. (2016): *Why Platform Disruption Is So Much Bigger than Product Disruption*. Harvard Business Review. Available: https://hbr.org/2016/04/why-platform-disruption-is-so-much-bigger-than-product-disruption Sourced 20.5.2016

Schiller, B. (2014). *The Sharing Economy Takes On Electricity, So You Can Buy Power From Neighbors*. Available: https://www.fastcompany.com/3036271/the-sharing-economy-takes-on-electricity-so-you-can-buy-your-power-from-neighbors Sourced 9.11.2016

Schiwieter, N. & Flaherty, T. (2015): *A Strategist's Guide to Power Industry Transformation*. From the Autumn 2015 issue of strategy+business Sourced: http://www.strategy-business.com/article/00355?gko=9fa18

Sonnen, (2016): *sonnenCommunity*. Sourced: https://www.sonnenbatterie.de/en/sonnencommunity

Sunverge, (2016). *It Doesn't Have to be a Battle Between Utilities and Solar Power Providers*. Sourced: http://www.sunverge.com/it-doesnt-have-to-be-a-battle-between-utilities-and-solar-power-providers/

Taneja, H. (2014). *Unscaling the Trillion-Dollar Power Industry*. Techcrunch. Sourced: https://techcrunch.com/2014/08/21/unscaling-the-trillion-dollar-power-industry/

Tesla, (2016a). *Powerwall*. Sourced: http://www.teslamotors.com/powerwall

Tesla, (2016b). *Solar*. Sourced: https://www.tesla.com/solar

Trough, K. (2015). *The First Energy Revolution – Tesla Energy Changes Everything*. Sourced: http://cleantechnica.com/2015/07/21/first-energy-revolution-tesla-energy-changes-everything/

Vandebron (2016): *Home page*. Sourced: https://vandebron.nl/

Virta, (2017a). *Home page*. Sourced: https://virta.global/

Virta, (2017b). *About us*. Sourced: https://virta.global/about-virta-ltd/

Virta, (2017c). *Services for EV drivers*. Sourced: https://virta.global/services/end-user-services-ev-drivers/

APPENDIX

Appendix 1 – Abbreviations

Advanced metering infrastructure = AMI

Charging business as a service = CBAAS

Combined heating and power = CHP

Community energy storage = CES

Distributed energy resource = DER

Distributed generation = DG

Distributed system operator = DSO

Demand response = DR

Electric vehicle = EV

Energy storage = ES

Multi-sided platform = MSP

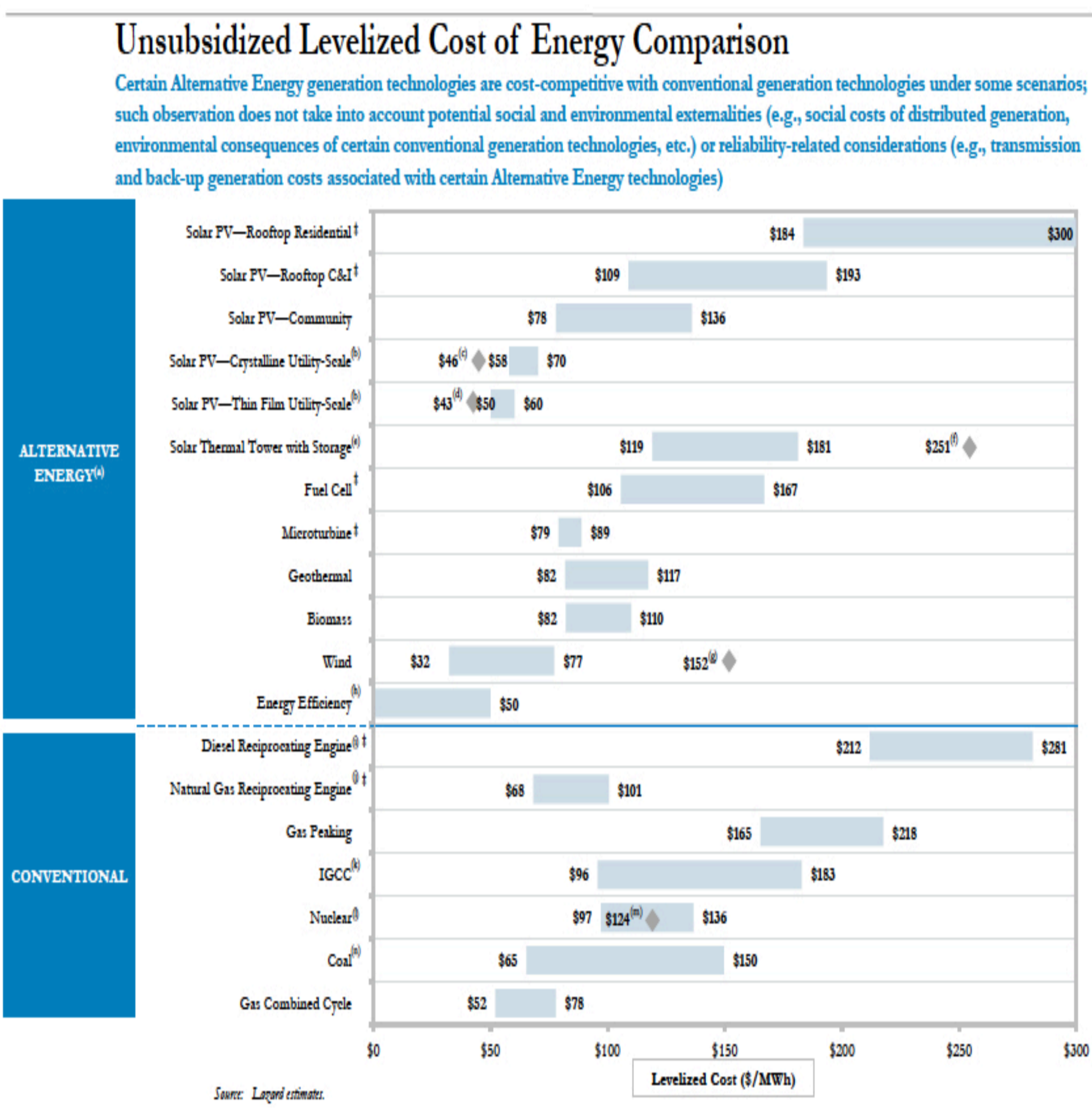
Photovoltaic = PV

Transmission system operator = TSO

Vehicle-to-grid = V2G

Virtual power plant = VPP

Appendix 2 – Unsubsidised Levelised Cost of Energy Comparison



Unsubsidised Levelised Cost of Energy Comparison (Lazard, 2015, 2)

Appendix 3 – Interview Structure

Personal background
- Work history
- Current position

Traditional electric power industry
- The value chain of the industry
- The dominant business logic

Key technological drivers
- Significance of each driver
- A change in the dominant logic

Customer perspective
- Customer's traditional role
- Changes in the role
- Edge empowerment

Utility perspective
- The role of the future utility
- Business development in the future

Ecosystem development of the electric power industry
- Is there an on-going transformation
- Describe the transformation
- New ecosystem participants
- Structural changes in the industry